POWER

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How Do You Read?

THE author of a well-known book on Whist insisted that it should be read with the cards in your hand.

There is a lot of difference between reading perfunctorily and mechanically a lot of paragraphs and pages and actually following the game that the author is trying to play.

When you have read a paragraph, can you close the book and mentally review what it has said? When you have read a description of a device or appliance, can you take a pad and pencil and sketch at least its main features and make apparent its method of operation?

That is the way to make what you read a part of your mental outfit, to build it into your mind and make it your own.

How many times a subject will come up in debate or conversation, or a need will arise in one's work for information about which he has an illy defined recollection of having read in that non-absorptive way and of which he could talk authoritatively or which he could use to advantage if he had read it with more concentration.

And such attentive, questioning, understanding reading not only adds to one's stock of knowledge, but develops the mental processes so that one gets not only what the author really means, but what he himself thinks about it, and when one really gets to thinking, the possibilities are boundless — but it hurts some men to think.

F. R. Low

United States Public Printer Makes Large Saving by Rebuilding Power Plant

PROBABLY the average reader who has not had an opportunity to visit the government printing office, Washington, D. C., does not know that this plant is the largest printing plant in the world, occupying over 700,000 sq.ft. of floor area. The building and plant equipment represent an investment of $6,500,000. There are 4,000 employees, 21,000 tons of paper was used in 1924, and the cost of operating the plant was $12,000,000. Exclusive of government bonds and paper money, practically all the government printing is done in this plant, including post cards and money orders. The plant is run day and night, and considerable of the work corresponds to that in a newspaper office. For example, on the morning of each legislative day of Congress, printed copies of all proceedings incidental to the previous day's session are on the desks of the members.

BY DISMANTLING its power plant and converting it into a substation, and taking power from the Capitol's power plant, the United States Public Printer, Washington, D. C., has succeeded in making a saving of over $37,000 per year for power and steam. If the value of the condensing water, which was taken from the city's main is included, the saving per year amounts to over $60,000 In addition nearly 20,000 sq.ft. of floor space was made available, and the efficiency of the Capitol's power plant materially increased.

In the printing plant, as in any large manufacturing establishment, a dependable power supply is of special importance. It is of interest to know that the government printing office was one of the first industrial plants in the country to install electrical machinery. This was an electroplating dynamo put in service in 1879, and in 1881 and 1882 an electric light plant was put in operation. From this beginning the use of electric power has increased until now over 5,000,000 kw.-hr. per year is used. When the present Public Printer, Hon. George H. Carter, came into office in 1921, the government printing office had outgrown the capacity of its power plant and it was necessary to make some change that would provide not only for the present requirements but also for the future. The power plant consisted of eight hand-fired boilers of 3,000 sq.ft. and two mechanical stoked of 5,000 sq.ft. of steam-making surface; one 1,000-kw. turbine, one 300-kw. and two 600-kw. reciprocating-engine-driven direct-current generators. The engines and turbine operated condensing on water taken from the city's filtered water system, and with the exception of what was used for industrial purposes this water was discharged into the sewer after passing through the condensers. This plant not only supplies power and steam to the printing office, but also to the Washington City Post Office which is near-by.

Two plans for the proposed enlargement of the plant presented themselves. The first was to enlarge the existing power plant by replacing the Corliss compound engines with turbine-driven units of greater capacity and enlarging the boiler plant. The second plan was to abandon the power plant and install a substation and take the power from the Capitol power plant. All considerations were against the enlargement of the power plant, owing to lack of space, insufficient water supply for condensing purposes, the hauling of coal in trucks over a mile from the railroad sidings and limited storage space for coal and the removal of the ashes.

The Capitol power plant of 8,000-kw. capacity needed an increase in load for more efficient operation. This plant is located on a railroad siding, has a direct condensing-water supply from the Potomac River, and is connected with the Washington Navy Yard power plant, thus providing a breakdown service in case of emergency.

For these reasons the decision was made to dismantle the generating station and connect to the Capitol power plant. This also necessitated that steam for heating and other purposes be brought directly from the boilers in the Capitol plant. To do this a tunnel seven feet high by four feet wide and approximately 2,700 ft. long was constructed, between the Government Printing Office and the Washington City Post Office and the Senate office building, where connection was made with an existing tunnel and steam mains.

After a careful consideration of various power systems it was decided to convert part of the old engine room into a substation and install three 1,500-kw. shunt-wound booster-type synchronous converters. This provided for doubling of the present load requirements and still have a 50 per cent reserve. The arrangement also allowed the use of the present three-wire 120- and 240-volt feeder system and 240-volt direct-current motors.

Current is furnished at three-phase 25-cycles 6,600-volts from the Capitol power plant, over duplicate feeders, but in emergency, provision is made at the Capitol power plant to transfer the entire load to the Washington Navy Yard. The duplicate feeders are protected at each end with automatic oil switches, which are controlled by overload and reverse-power relays. For operating of the tripping circuits 120-volt direct current from a storage battery is used, of sufficient capacity to take care of the substation lights in an emergency.

The high-tension current comes to a bus structure in the substation and from there to three 1,650-kva. three-phase self-cooled type transformers, where it is stepped down and changed to six phase for the rotary

converters. In the transformers suitable taps are brought out for the neutral of the three-wire direct-current system. Each converter is arranged for starting as an induction motor by means of a three-pole double-throw switch, which first allows starting on partial voltage and then throwing to full voltage before closing the neutral switch. Connections between the transformer secondary terminals and the converters' slip rings, and between the machines' commutators and the busbars on the switchboard are made with copper bars 4 in. wide by ¼ in. thick, carried on insulators in the open.

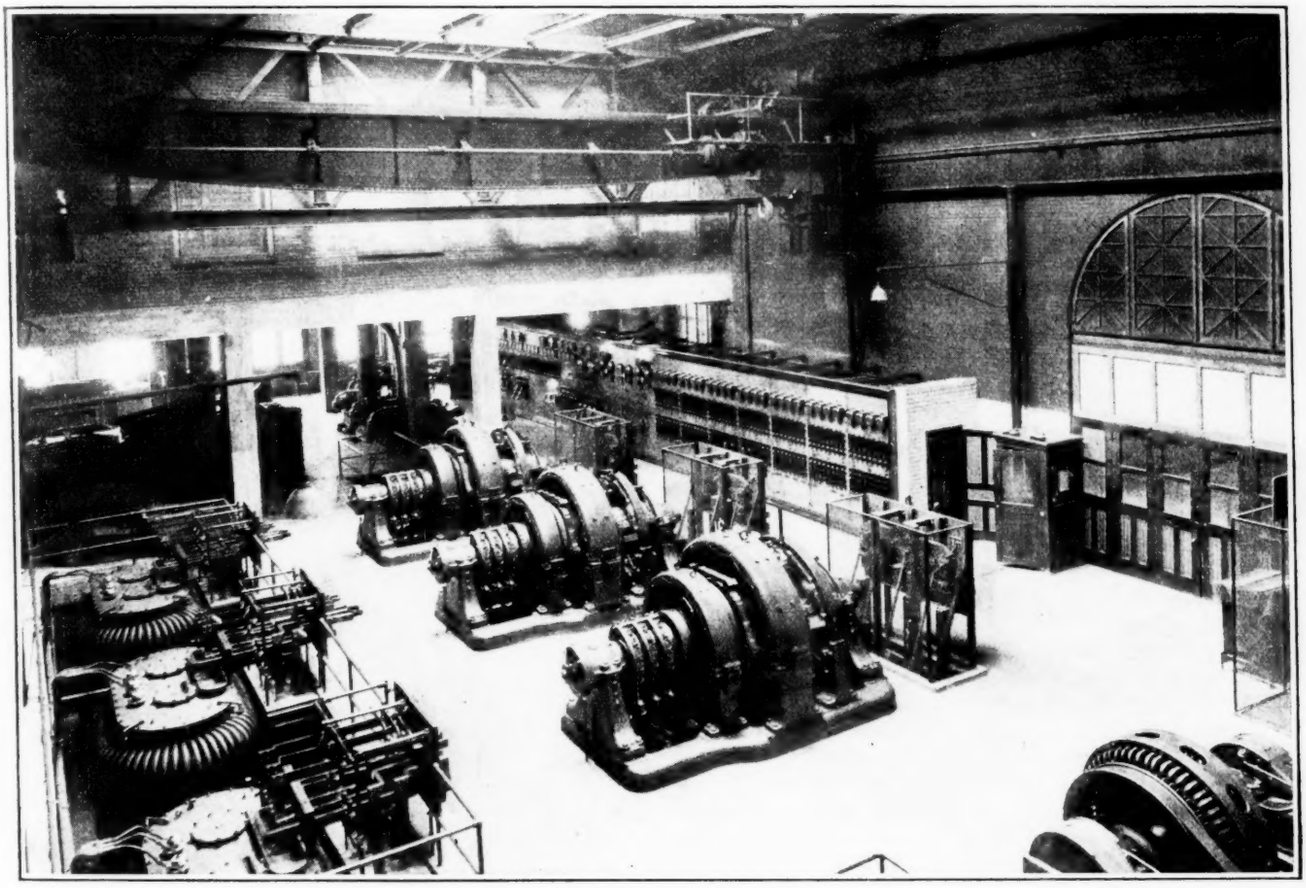
From the substation switchboard 76 feeders run to the different parts of the printing office and to the Washington City post office. There is a total connected load to the substation of 5,900 kw., 5,325 kw. of which is in the Printing Office, made up of over 1,400 motors, about 7,500 lights and 350 heating devices. At present the average printing-office load during the day is about 1,000 kw., or about 19 per cent of the converter capacity installed.

The substation also contains two 1,500-cu.ft. per min. air compressors, driven by 230-hp. synchronous motors. Two 400-cu.ft. compressors are being installed to carry night loads. In addition to these there is the motor-driven service water and fire pumps.

Provision is now being made to transfer the electric heating load in the cafeteria from direct- to alternating-current service. A new installation of electric metal pots to replace gas pots on monotype machines will also be operated on alternating current, thus saving the conversion losses. The present electrically heated linotype pots, as well as the new monotype pots, will be controlled by circuits automatically closed by clocks, so that the required number of machines for both day and night work will be properly heated in time for the operators.

The plant originally included a 20-ton absorption refrigeration plant. When the steam plant was dismantled a 25-ton compression-type refrigerating machine was installed and the absorption equipment is held in reserve. For all purposes, in the substation, there are installed 880 hp. in motors.

For heating and process purposes saturated steam is supplied at about 65 lb. gage from the Capitol power plant through two 8-in. mains. Condensate from the different heating processes is not pumped back to the power plant, but is turned into the hot-water systems.



Substation occupies space used in the old plant for an engine room

Improvements Resulting from Rebuilding the Power Plant

This change-over has resulted in a number of improvements. First there has been a direct saving in the operation of the Printing Office power plant of $25,032, when compared with the conditions of 1922-23, the last year the steam plant was operated. This saving has been accomplished by a more economical use of steam, a very considerable reduction of the operating force, elimination of the cost of hauling coal by truck, as well as the more economical generation of steam and

electricity possible in the larger plant which required only a small increase in its operating force to carry the added load. The cost of steam was 61½c. per 1,000 lb. generated in the old plant, while it is now purchased at 47.6c. per 1,000 lb. The electric power is now metered at the Capitol power plant at a rate of 1.5c. per kw.-hr., which becomes 1.87c. when transmission, conversion and substation operating charges are added.

Since 1922 the cost of coal delivered to the Printing Office plant has decreased about 25 per cent, while labor costs have increased 39.4 per cent. Figuring the saving on the basis of present-day fuel and labor costs, purchasing power and steam from the Capitol plant shows a saving of $37,332 over operating the old plant. In addition to this the Post Office steam consumption has been reduced 11,725,000 lb. per year, which is equivalent to a saving of 650 tons of coal, or about $4,000, making a total saving of over $41,000, during 1924-25 over 1922-23 operation. Further savings resulted to the Post Office by being able to purchase steam at a decreased cost, which amounted to $4,600. The total saving to the Post Office due to economies in the use of steam and the reduction in its cost has been $12,511.

Large Saving Made in Filtered Water Taken from City Mains

The steam plant operated condensing on filtered water taken from the city's mains. With the exception of the part of this water that was used for the various services, the rest was discharged into the sewer. Although the Printing Office did not pay for this water, the change over has resulted in a saving to the city of about 350,000,000 gal. per year, which if charged for at the regular rate, would have amounted to over $23,000. Another benefit obtained by the Printing Office from the change-over was making available nearly 20,000 sq.ft. of floor space, valued on a rental basis at $7,500 per annum, which was badly needed for increasing the size of the printing plant. This space was obtained by putting a second floor in the boiler room and over part of the engine room. In addition to these direct savings the dirt from coal and ashes incident to operating a power plant has been eliminated. Also capacity has been made available to take care of all the printing office's power needs well into the future.

In addition to the foregoing the Capitol power plant obtained a very desirable load, which it was in need of to absorb some of its excess capacity. This load on the Capitol power plant has not only resulted in materially increasing its efficiency, but made possible realizing an income from equipment that otherwise would have remained idle. The Printing Office load has a daily load factor of about 60 per cent and the power factor is generally slightly leading. The load factor is arrived at by taking the peak load, which is about 1,500 kw., multiplying it by 24 and dividing this product into the kilowatt-hours recorded on the watt-hour meter in the feeders from the Capitol power plant.

The work of changing over the plant was initiated by Hon. George H. Carter, Public Printer, and the details were worked out under Major Walter R. Metz and his successor, Alfred E. Hanson, superintendent of buildings. The electrical engineering part of the work was under the direct supervision of Walter A. Browne, chief engineer, piping under O. H. George, chief pipefitter, and machinery installation, other than electrical, under M. J. McInerney, chief machinist.

Air-Steam Ignition for Oil Engines

By Robertson Matthews

IN THE Langley Field experiments with a high-speed solid-injection engine the adaptation of the Liberty cylinder to compression ignition did not give sufficient capacity at high speed with an approach to sweet running. As a result some trials were made using this injection system but reverting to electric ignition. In this case the operation was normal four-stroke-cycle Liberty engine operation with the exception that the fuel-injection system was substituted for the carburetor.

Two systems of injection are available with spark ignition, these being internal, or injection into the cylinder as in oil-engine practice, and external, or air-stream injection, the fuel being injected into the air-stream prior to its entering the inlet valve. This latter method gives better mixing and more time for vaporization. The lipped nozzle was placed to discharge in the same direction as the incoming air stream. The output obtained with this system exceeded all recorded

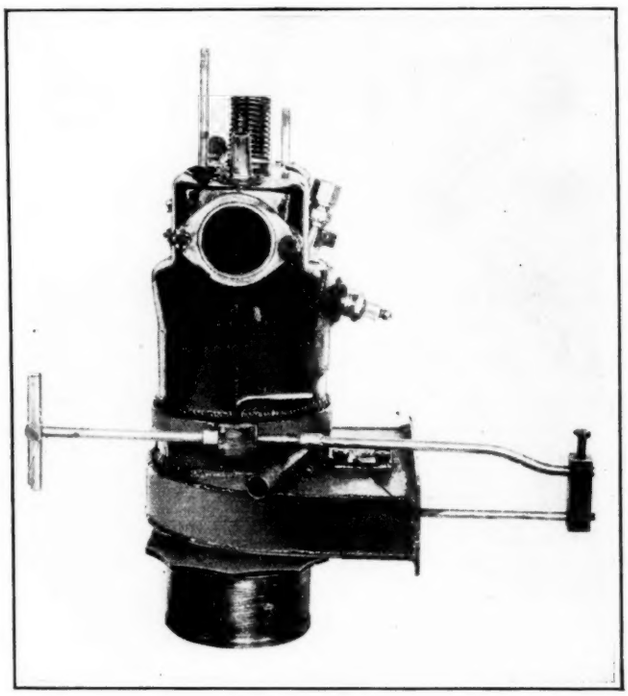


Fig. 1—Liberty cylinder converter for two-stroke-cycle operation

values obtained from similar single-cylinder Liberty experimental engines using carburetors. At 1,900 r.p.m. the brake mean effective pressure was 127 on a 50-50 mixture of gasoline and benzol.

Unfortunately, this work was not carried far enough to determine the best fuel economy obtainable when getting high capacities. Noteworthy, however, was the relation of size of orifice to engine capacity. Though the lip nozzle gave finer atomization with the small than with the large orifices, the capacity during these runs increased with increase in size of orifice. Since the pump plunger was spring-actuated, this may be

interpreted to mean that the capacity went up as the interval of injection was decreased, or as the average time for vaporization was increased. Apparently, time meant more than fineness of atomization.

The capacities obtained from the Liberty cylinder with injection substituted for the carburetor as the only departure, aroused interest in the possibilities of two-stroke-cycle operation with injection and electric ignition. Electric ignition would insure capacity with moderate pressures, and fuel injection would save the fuel wasted by scavenging as occurs when using a carburetor. For aircraft service this involved the extra problem as to whether the scavenging-air pressure and quantity of scavenging air could be kept within the limits permissible with aircraft equipment. Since four-stroke-cycle airplane engines are in service that can operate at 2,400 r.p.m. and give a higher brake mean effective pressure than could be expected from a two-stroke-cycle engine, it was evident that the r.p.m. of this injection two-stroke-cycle engine must exceed 1,200 r.p.m. A substantial margin in horsepower had also to be allowed to take care of the blower. An unofficial decision was, therefore, made to strive for 60 b.hp. at 1,600 r.p.m. with an 0.6 lb. per b.hp.-hour consumption of a mixture of gasoline and benzol. Assuming the blower horsepower to be 10, there would remain 50 b.hp. per cylinder or 600 b.hp. from a 12-cylinder Liberty, which is doing well when it turns up 400 b.hp. at 1,700 r.p.m. when operating on the four-stroke cycle. At the time of leaving this research 53 b.hp. had been obtained at 1,400 r.p.m. without correcting for the power consumption of the blower, and the fuel consumption was under 0.7 lb. per b.hp.-hour.

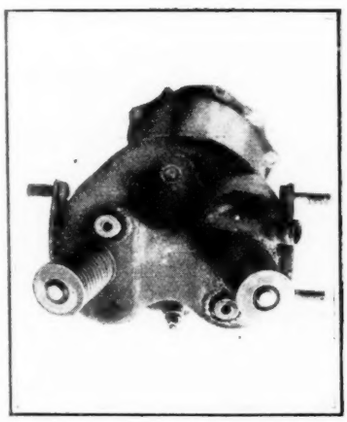


Fig. 2—Top view of Liberty cylinder

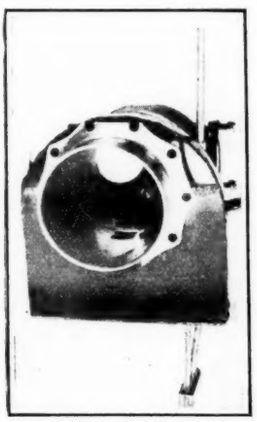


Fig. 3—Bottom of cylinder and air box

Changes in Engine

The essential work in adapting the cylinder for these results is shown in part in Figs. 1, 2 and 3.

The air box surrounding the ports was added by welding, as will be seen from Fig. 1. A new camshaft and gears were made to operate both the inlet valve and exhaust valve as exhaust valves. This arrangement of air box and valves gave up-flow scavenging. Besides regulating the air pressure at the blower, a throttle band operated about the inlet ports. Injection was tried at several points. One location was obtained by welding a boss to cylinder wall and jacket. Both internal injection through one of the spark-plug holes and external or air-stream injection into the wind box were tried. It was this air-stream injection that gave the high capacity above mentioned. A special spray box leading up to one of the ports was devised in order to obtain this result. At 1,400 r.p.m. the exhaust valves were fluttering; this condition threw out attempts at 1,600 r.p.m.

The scavenging air pressure for this high capacity was only between 5 and 6 lb. gage. The quantity of air used, however, was uncertain. A gasometer was needed to make the air measurements but was not supplied. Efforts to measure the volume of air by means of an orifice box were requested. Some of these measurements showed air consumptions that would have done credit to a four-stroke-cycle engine, and hence will not be given much weight. Air pulsations were evident in spite of considerable effort at baffling and using rubber diaphragms. Hence, results which appeared promising with the two-stroke-cycle in the way of brake mean effective pressure, fuel economy, and scavenging air pressure were rendered of doubtful value because of the lack of proof that the quantity of air supplied could be allowed. The design does appear to offer hope of high output with air stream injection and two-stroke-cycle operation.

Gennevilliers Power Station Largest in Operation

In the Aug. 1 and Aug. 15, 1922, issues of *Power* was described the Gennevilliers plant of the Société l'Union d'Electricité, near the City of Paris, France. This plant at that time contained five 45,000-kva. steam turbo-generators. In 1924 a sixth 45,000-kva. unit was put into service. At present two 60,000-kva. machines are being installed by the Société Alsacienne de Construction Méchaniques. This gives the plant a capacity of 390,000 kva. and makes it the largest single steam power plant in the world, and it equals or exceeds in capacity any water-power plant in operation.

The generators are designed for three-phase 6,000 volts 50 cycles at 1,500 r.p.m. The original machines, although designed for a maximum rating of 45,000 kva., have carried loads up to 55,000 kva. The new 60,000-kva. normal-rating machines, with a maximum rating of 65,000 kva., are of the same dimensions as the earlier machines installed by the same company, and the stators and rotors of the old and new machines are interchangeable. The increase in capacity was obtained by modifications in the original design and increasing the size of the air coolers. How this was possible can be readily understood from the fact that the original machines were capable of carrying 55,000-kva. loads at very low power factor.

The original machines were among the first to use a closed system of ventilation. In this system, after the air is forced through the generator, it passes to a cooler, through which the condensate is pumped on its way to the boilers; thus part of the losses in the generator are returned to the boilers. To insure sufficient condensate for the coolers at all times, under light-load conditions an automatic valve opens and returns part of the condensate to the condenser. This station was also one of the first to adopt a number of other features, such as steam temperatures of over 700 deg. F., stage heating of the feed water, etc., that have become common practice in large modern steam plants.

Compressed Air Used for Hydraulic-Turbine Inspection

By C. R. REID*

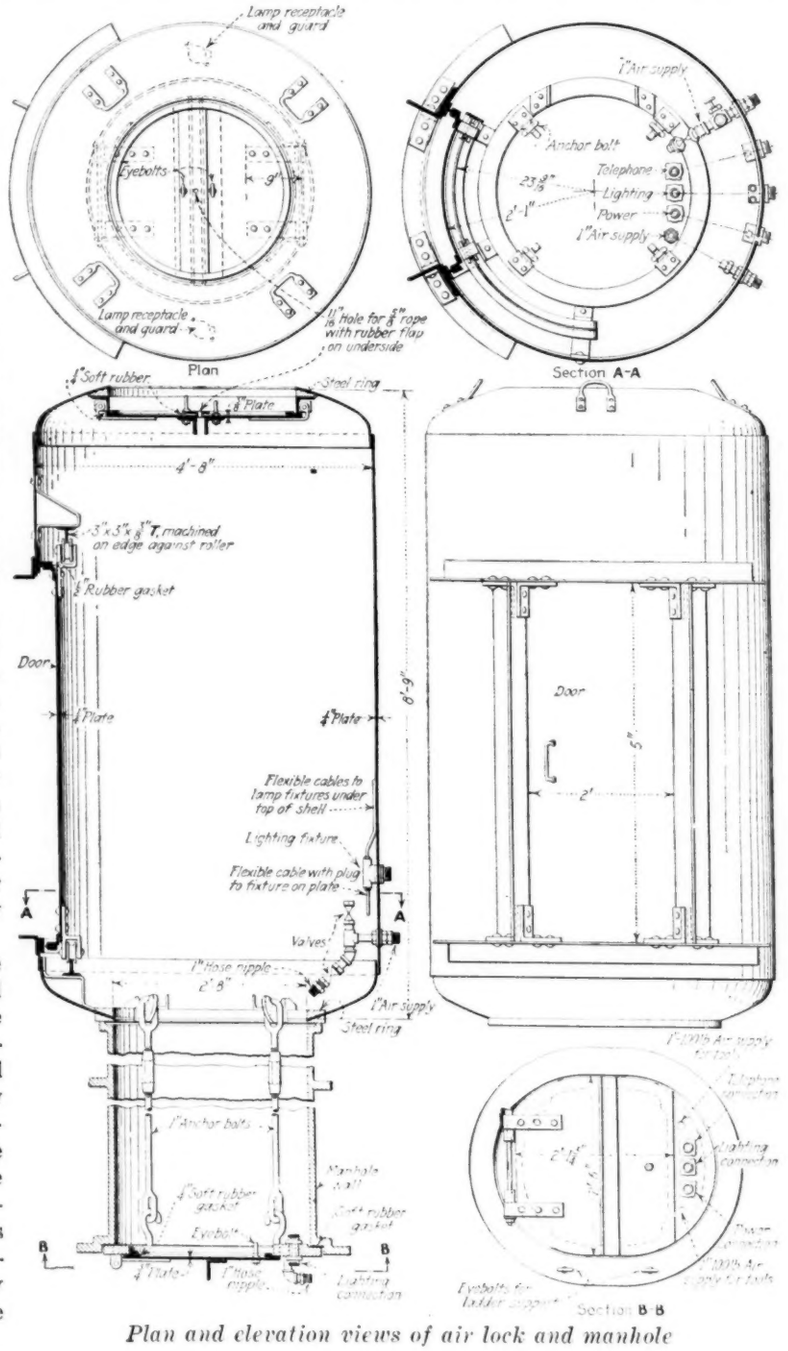
IT IS desirable to make an inspection of hydraulic turbines at frequent intervals, in order to ascertain the condition of the runner, guide vanes and other parts subject to wear or breakage. In the case of a modern vertical hydro-electric unit, the runner is often set so low that it is below the tailrace level during periods of high water. At such times the wheel chamber may be unwatered by closing the tailrace opening with stoplogs and pumping out the water in the wheel pit. However, the objection to the use of stoplogs is that in the case of large units several days are required to put the stoplogs into place and pump out the water.

In the La Gabelle power house of the St. Maurice Power Co., compressed air is used to lower the tailwater in the wheel chamber of the 33,000-hp. turbines when inspections are to be made. A cylindrical air-lock chamber is provided, which may be clamped over a manhole opening in the generator floor that connects with the wheel chamber. Conductors for telephones and electric wires are introduced into the air-lock through airtight glands.

The construction of the air lock is shown in the figure and consists of a plate-steel cylinder closed at the top, 4 ft. 8 in. in diameter by 8 ft. 9 in. high, equipped with an airtight door 2x5 ft. in dimensions. Entrance into the turbine scroll case is through a manhole in the power-house floor about 13 ft. deep. At the bottom of this manhole, in the ceiling of the wheel chamber, is a trapdoor that swings downward. In the frame of this door are four hooks to which the air lock is anchored by bolts with turnbuckles.

The cover at the bottom of the manhole is a permanent part of the installation and has exerted upon it the full water pressure during normal operation. When the headgates are closed, the water in the scroll case falls to tailrace level, which is below the position of the manhole cover. Materials can be lowered by a crane through the top of the air lock into the scroll case before the air pressure is applied. This arrangement is useful in taking in and out timbers for scaffolding. In order to take in material under air pressure, it will be necessary to take them first into the air lock and close it, then apply the air pressure.

Air pressure is supplied to the scroll case through one of the air vents. These air vents are on the downstream side of the headgates, are 12 in. in diameter and 6 in number for each unit. These air vents are closed off with suitable covers, and a connection is made to a four-inch air line running the length of the power house. A pressure gage shows the pressure on the scroll case. Usually, ten or twelve pounds is sufficient to force the water down to the desired level. An attendant in the gatehouse admits air until the required pres-



Plan and elevation views of air lock and manhole

*Power-House Superintendent, Shawinigan Water and Power Company, Shawinigan Falls, Quebec.

sure is obtained and maintains this pressure until the inspection is completed.

Ordinarily, the inspection crew gets inside the air lock, the manhole cover is opened and the door of the air lock closed. The air pressure is then applied by the gatehouse attendant, and when the water has been forced down far enough, the inspection crew descends into the scroll case. After the inspection is completed, the crew returns to the air lock and notifies the gatehouse attendant by telephone to exhaust the air. When this has been carried to a sufficient degree, the door of the air-lock is opened.

In case it is desired to pass in and out of the scroll case and keep air pressure on it, a special manhole cover is provided with air valves and connections for telephone and electric light. With this in place the air pressure may be applied to the scroll case. The crew then enters the air lock, closes the door and equalizes the pressure by means of a valve in the manhole cover, then the cover is lowered out of the way. On coming out, the reverse process is followed and after the valve in the manhole cover is closed, a valve in the shell of the air lock is opened and the pressure equalized with that of the atmosphere.

This special manhole cover is shown in place in the figure. In the frame that supports the manhole cover in the ceiling of the turbine casing are two 100-lb. air-supply connections, which are connnected by one-inch hose to two similar connections near the base of the air lock. Three other connections are also provided between the turbine casing and the air-lock base, one each for telephone, lighting and power circuits, for use by the workmen when working on the runner and gates. These are all clearly indicated in plans *A-A* and *B-B* in the figure.

In the top of the air lock is a two-part cover with a hole for a ⅝-in. cable. This allows lowering or removing heavy tools and equipment with the power-house crane in and out of the turbine casing when the air pressure is applied.

Rebuilding a Large Commutator in Place on a Generator

Methods Used in Rebuilding a Commutator on a Large Direct-Current Generator Where the Commutator Could Not Be Removed to a Repair Shop

BY EDWARD JAMES

COMMUTATOR repairs are and should be seldom attempted in the field, and the more this point is stressed, particularly where shop work is possible, the better for both the customer and the manufacturer. However, the nature of some generator installations makes repairs to a commutator on a machine a matter not only of expediency but of necessity, in which case the field engineer must make the best of local equipment in order to put out a first-class job. In the first place the actual rebuilding of a commutator in the field is essentially slow work owing to lack of facilities that make for speed and the work of rebuilding being done in a horizontal position rather than a vertical.

The commutator dealt with in this article is 40 in. in diameter with 630 bars 24 in. long and weighs over one-half ton without insulation, therefore substantial cribwork is necessary to support it when the end rings are loosened or removed. On the machine in question a serious ground occurred, which badly burned a group of bars. As this failure to ground burned off parts of the back ends of a number of bars, as indicated in Fig. 1, they became loose on the ring and rose up above the surface of the commutator and formed a high spot.

Removing the Brush Rigging

The first thing to do when making such a repair is to remove all auxiliary apparatus such as brush yoke, pedestals, etc. Unfortunately, in this case the bearing pedestal could not be removed owing to the way it was installed, therefore the removal of the commutator to take it to a repair shop was out of the question, as it was on the same shaft as a heavy flywheel. The generator was an engine-driven type, assembled in the second story of the building, after which the building that housed the machine was erected.

Having completed the removal of the brush rigging, two cradles of 2x8-in. material were made and a semi-circle cut in them of a radius equal to that of the commutator, with sufficient allowance for one thickness of cardboard, Fig. 2. These cribs were then placed under the commutator, one barely clearing the risers

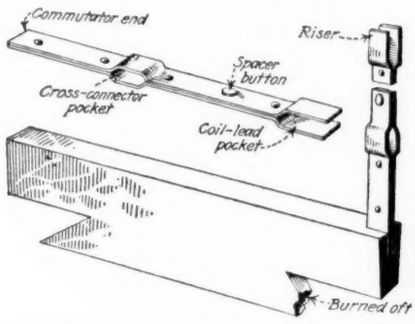


Fig. 1—Commutator bar and riser, showing where the burn occurred

at the back end of the bars and the other at the bearing end. After wedging the cradles tightly under the bars the former were nailed together as a unit and blocked at both sides to prevent side motion.

The bars are now supported and the end ring may be removed without danger of the commutator collapsing. For additional support on this commutator the risers above the cradle were held in place by two boards with ¼-in. bolts extending through the armature spider

and fastened on the back end of the core. Sufficient room was left between the ends of the board to allow inserting or removing bars as the case might require.

Disassembling the Commutator

Having the cradle in place and the end rings removed, the actual disassembly begins by unsoldering the cross-connectors and coil leads, with proper attention that solder does not flow into places where it is not desired. This is particularly essential when one is in doubt whether or not the entire job must be rebuilt, but should be given special attention anyway. In the disassembly of this commutator the unsoldering was done as the bars and the risers were removed. The bars were removed, examined, loose mica removed and then piled in groups according to their condition. The removal of bars was effected down to the cradle, at which time this support was taken away and the remaining bars removed. After this the old mica insulation can be removed from the end rings, and a general cleaning can be given to the exposed parts, which include the coil and cross-connector ends; repair of burned iron, which may necessitate the extensive use of a chisel and file, followed by filling in of burned places with iron cement, plaster of paris or a glycerin and litharge compound. The last-named is the best filling compound where insulation is present.

When the total number of new bars required is known, they can be ordered from the factory along with new insulation for the commutator. While waiting for the new bars an extensive cleaning program must be accomplished. Old mica must be scraped from the bars followed by a fine sandpaper so that every particle of insulation is removed. It is well to provide a pot of solder for dipping the ends of the bars and risers, after which all solder must be removed from the surface of the bars. This dipping thoroughly cleans the cross-connector and coil lead pockets. Checking the riser spacers to see that they are in good condition is about

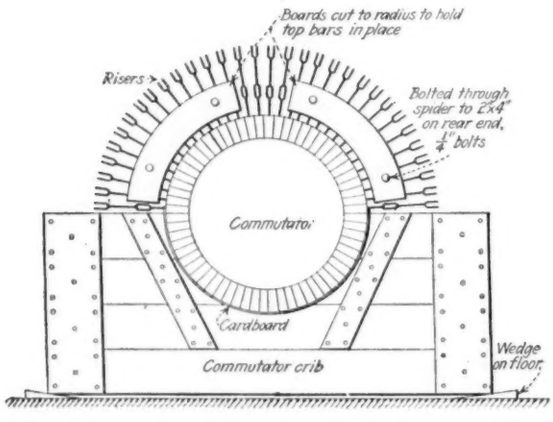

Boards cut to radius to hold top bars in place
Risers
Bolted through spider to 2x4" on rear end, ½" bolts
Commutator
Cardboard
Commutator crib
Wedge on floor

Fig. 2—Method of supporting the commutator

all that remains on the cleaning program. This has placed the old bars in good condition, and on receipt of new bars from the factory, together with insulation, the rebuilding can begin.

The inner V-ring of the commutator is insulated first. This is accomplished by heating the mica to a pliable state and molding it about a wooden dummy of the same circumference as the V-ring or slightly smaller, after which the ends are shaved for fit in circumference and in lapping the joints. The mica is then shellacked in place on the V-ring, which should be heated. If the dummy on which the mica is molded is slightly smaller in circumference than the V-ring, it will fit better when placed on the ring. If the workman so desires, the mica may be molded on the end ring.

Stacking of the bars begins at the bottom. Mica is placed in position at the same time, and the work should progress evenly on both sides of the center.

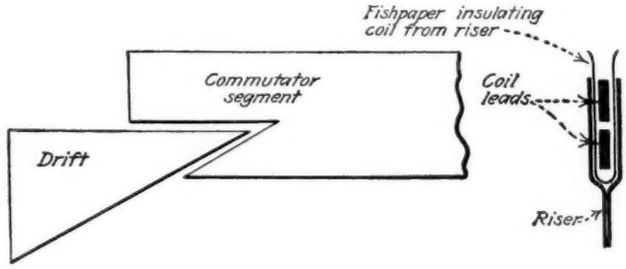


Fig. 3 (Left)—Shows how fiber drift was used to drive segment to place. Fig. 4 (Right)—Shows how coil leads were insulated from commutator for testing

Care should be taken to see that the cross-connector and coil leads get into their correct pockets and that the bars and mica drift together as much as possible, as the bars will crowd before the last bar is in place. Until the cradle can be put into use, the outer end ring is supported in place and used for assembling the bars and mica on.

No special trouble will be encountered until the commutator has been over one-half stacked. As soon as it is convenient, the cradle should be put in place and wedged up snugly to the commutator. As the work progresses, the bars will begin to crowd on the cross-connectors at which time bars can be left out, preferably those that have neither cross-connector pockets or spacer buttons. When the work has progressed far enough, the boards, shown in Fig. 2, can be placed on the risers to hold those bars in place that are beyond the cradle and the remaining bars put in place.

Replacing the Skipped Bars

The next operation is to replace the bars that have been skipped. To accomplish this the commutator is wedged apart at the proper places and bars inserted. This method has its limitations, and the last few bars are heated over a flame or steam plate, a coat of shellac applied and the insulation then fixed to the bars under pressure on a flat surface. This makes a unit of a segment and two pieces of insulation, which is easier to insert after wedging the commutator apart. When replacing the last few bars, a wire band should be placed about the commutator before wedging it apart, otherwise some of the bars are liable to be forced out of the commutator.

When placing the last few bars, entry of coil ends into the riser clips is effected by the use of small pieces of tin or one-sixteenth inch fiber. The drifting of the bars to place is done with a fiber or wooden block, as shown in Fig. 3, that fits in the angle of the segment. Fiber, if available, is better than wood. In no event is a hard hammer or other metal object to be used on any part of the copper segments, as a turned edge may result in future breakdowns. The insertion of the last few bars calls for the greatest care to insure that no

burrs are left on the bars and that the mica is in good condition. This will call for a lot of patience on the part of the workmen, for a bar may be nearly in place only to find a damaged piece of mica, in which case the entire operation must be repeated, sometimes more than once. As the last bars are placed in the various positions on the commutator, it means turning the machine by hand to bring the open space on top for insertion of the bar.

Insulation of the outer end ring is not done until all the bars are in place. The end ring must be put on and tightened every time the commutator is turned to a

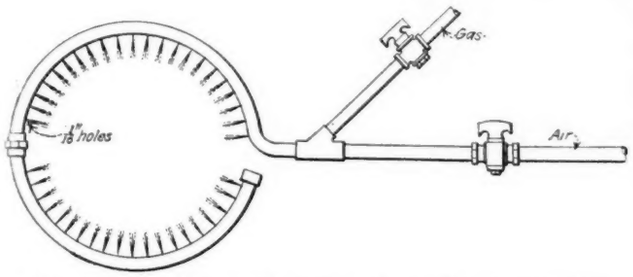


Fig. 5—Circular torch used to heat the commutator

new position, which might damage the insulation if it were put on the ring before all the bars were in place. As temporary insulation on the end ring, one-sixteenth inch fiber is used and held in place by binding with a cord.

When all the bars are in place, the commutator must be insulated from the coils by 10-mill fish paper, as indicated in Fig. 4, and a test made for grounds and short-circuits in the commutator before and after the end rings are put in place.

Insulating the commutator's out-end ring is accomplished in the same manner as the inside ring, by molding the insulation either over the ring itself or a similar ring of slightly smaller diameter, after which it is shaved and spliced. Before the ring is tightened up too tight, the commutator bars should be checked for position; otherwise they may be out of line with the shaft. Tightening the commutator is done by taking up a little on each bolt at a time. If it is found that the bars are out of line, they can be shifted with a block and tackle hung from above and connected to the bolts in the end ring, or the end ring can be blocked to the floor and the flywheel turned with the jack.

Final Tightening of the Commutator

For the final tightening of the end-ring bolts the commutator must be heated, and if gas and air are available this is easily accomplished by using a pipe torch, Fig. 5, to encircle the commutator. Other methods are the use of electrical heating elements encircling the commutator but insulated therefrom by asbestos. The construction of these elements will depend on voltage available; 90 ft. of No. 22 Nichrome resistance wire is the proper amount to use on a 220-volt circuit. I have also found that 175 ft. of 24 German silver wire is satisfactory for one heating element on 110-volt circuits.

The bolts should be tightened up, heat applied, tightened again and then the machine should be run for a time at near normal speed until it is cool, at which time another tightening can be made and the cycle repeated. One must take care that the bolts are not too tight or the commutator bars may be distorted.

When the operator is satisfied that the end rings are sufficiently tight, the bars should again be tested for grounds and short-circuits, after which the actual connecting can be done. In this work it is better to take care of the cross-connectors first. On the machine in question wedges were used to tighten the cross-connectors in their pockets and the best results obtained in soldering with the risers in a position inclined slightly below the horizontal; then any excess solder will have a tendency to run out. This position also applies to the coil connections and results in a job that is well soldered and easy to clean. Cleaning is best accomplished by hand with the use of scrapers made from hacksaw blades, files and sandpaper, ending with a minute inspection for particles of solder that cannot be dislodged by the use of air. A coat of air-drying varnish can be applied when the workman is thoroughly satisfied with the cleaning. After this work has been done, the commutator is trued, the mica undercut and the machine put into service.

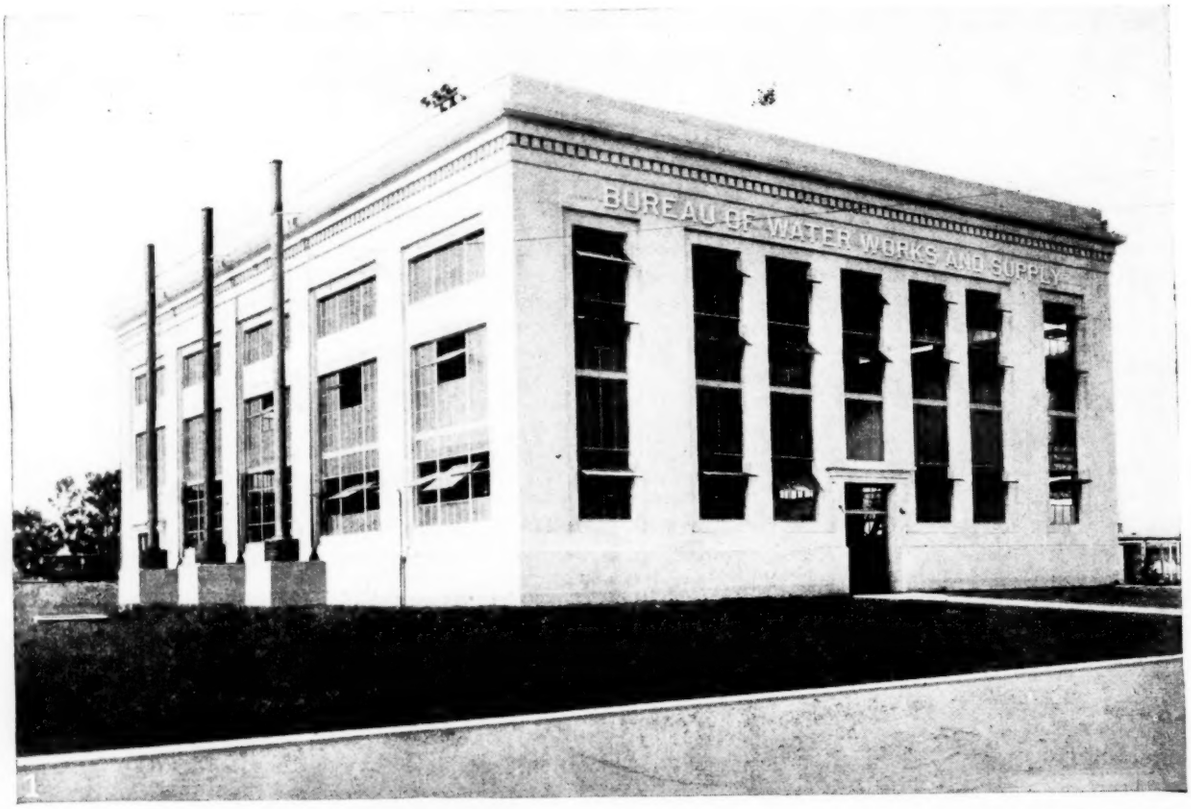
Air-Heater Performance

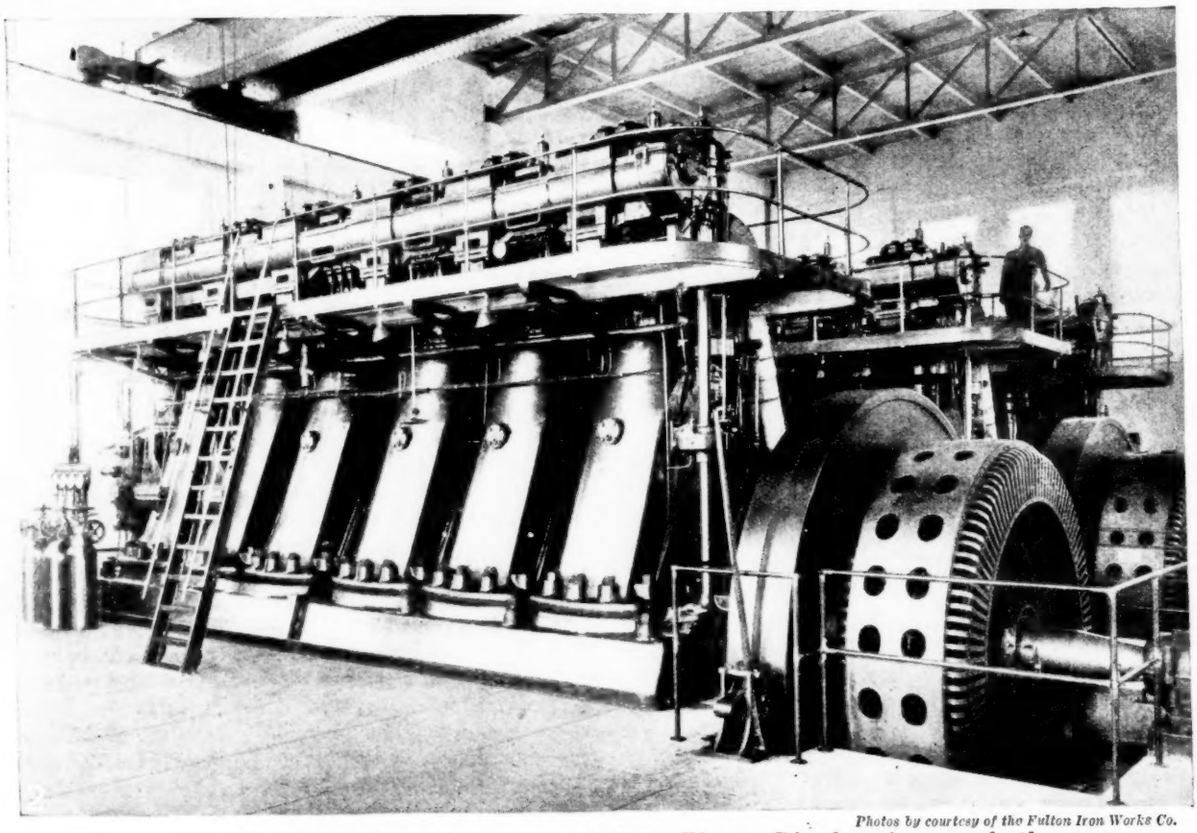
Tests on an air heater in the northeast section of the Kansas City Power & Light Co., as reported by the Prime Movers Committee of the N.E.L.A., show that the efficiency of the air heater, that is, the ratio of the heat absorbed by the air heater to the heat available to the air heater above the entering air temperature, is low, only about 16 per cent, but increases slightly with the rating and with the entering gas temperature. The rate of heat transfer in the air heater is also low, being a little over 1 at 125 per cent of rating and being a little less than 3 at 375 per cent of rating.

The heat recovered from the flue gases amounts to about 1.5 per cent of the heat value of the coal at 120 per cent of rating and about 2.3 per cent of the heat value of the coal at 400 per cent of rating. Undoubtedly, the rate of both heat transfer and heat recovery would be higher with a higher entering-gas temperature. The gas-temperature drop through the heater is nearly constant, amounting to about 70 deg. at 125 per cent of rating and increasing to about 80 deg. at 380 per cent of rating. The air-temperature rise through the heater is about 60 deg. at 120 per cent of rating, increasing as a straight line to about 100 deg. at 400 per cent of rating.

When interpoles first came into use, they were often added to non-interpole machines without any change in design other than possibly a different shape of main-field coils in order to accommodate the interpole windings, and these machines were usually of a slightly lower efficiency than the same machines without interpoles. Improvement in commutation or a wider range of speed were the chief objects sought in their introduction, and since the interpole field losses were added to the losses already existing in the machine and the output was not increased, the efficiency was lowered to a small extent. In the modern machines, however, where each part has been designed "from the ground up" with the idea of taking every possible advantage of the use of commutating poles, such as reducing the length of air gap, the amount of field copper and the magnetic density in the armature teeth, a machine of larger output, smaller losses and consequent increased efficiency has been developed.

One of Los Angeles, Calif., Diesel-Driven Water Works Plants





Photos by courtesy of the Fulton Iron Works Co.

Fig. 1—Exterior of San Fernando pumping station. Fig. 2—Diesel engines supply the power

The exterior view of the building proves that a power plant need not be unsightly even in a residential neighborhood.

Heating Feed Water by Stages

Why Stage Heating of Feed Water Results in Increased Economy

By CHARLES L. HUBBARD

THE practice of heating feed water by stages, with steam bled from the main turbine at different points, is becoming standard in central-station plants and under suitable conditions gives a higher efficiency than the old method of heating the feed by means of the exhaust from steam-driven auxiliaries.

In order to make a practical comparison of the two methods, it is necessary to have a clear understanding of the general principles involved in each case and to study the different factors from a theoretical point of view before applying the various changes and limitations that must be considered under the conditions of actual operation.

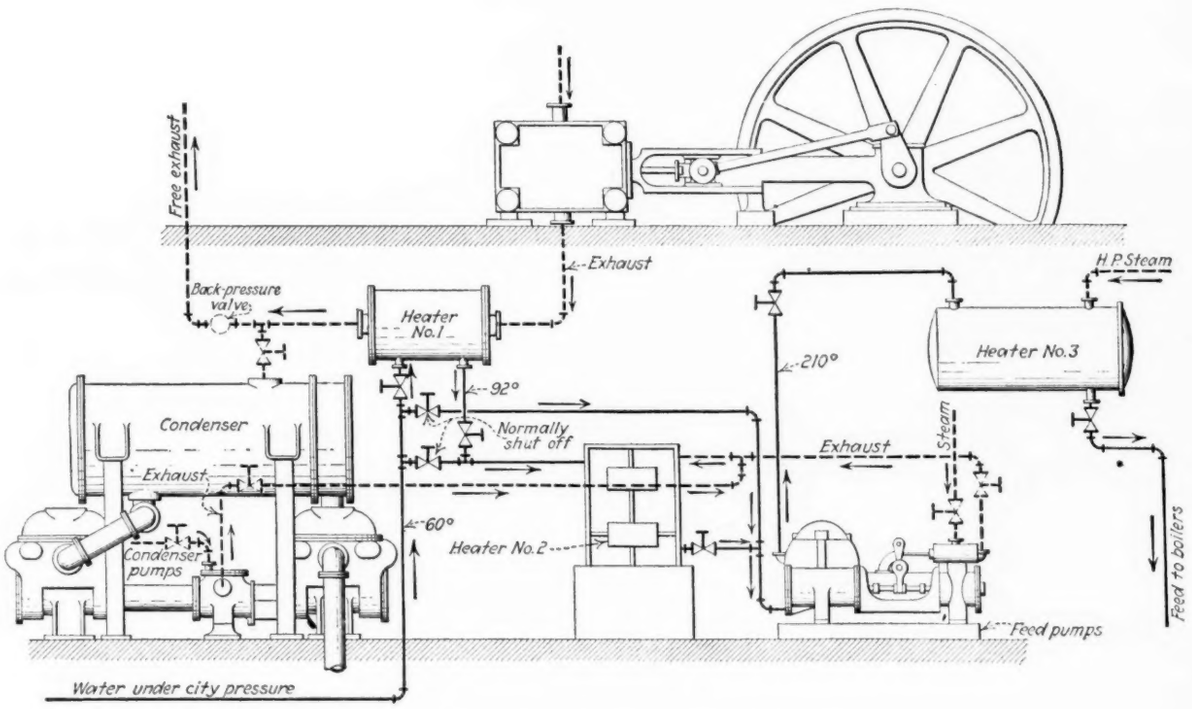


Fig. 1—Three-stage heating without bleeding

Stage Heating

Stage heating, in connection with feed water, is not new, although it has not commonly been spoken of by that name until brought about by the use of steam extracted from bleeder turbines at different pressures and temperatures.

The arrangement shown in Fig. 1 is probably familiar to most operating engineers and has frequently been used in condensing plants where it is desired to raise the temperature of the feed water to 300 deg. F. or more, for the purpose of precipitating the sulphates.

In this case the exhaust from the main engine passes through heater No. 1 on its way to the condenser. If the latter carries a vacuum of 28 in., the exhaust steam will have a temperature of 102 deg. Heater No. 2 takes the exhaust from the auxiliaries and is of the open type, carrying steam at atmospheric pressure and therefore having a temperature of 212 deg.

Heater No. 3 is supplied with live steam at 150 lb. gage pressure which has a temperature of 366 deg. Heater No. 1 is of the closed tubular type and will raise the temperature of the water to within about 10 deg. of the steam, or 102 — 10 = 92 deg. No. 2 is of the open or direct type where the steam mingles with the water, in which case there will not be more than 2 deg. difference, giving the water a final temperature of 212 — 2 = 210 deg.

Heater No. 3 is of the open or direct-contact type, but operated under pressure. The water in heater No. 3 will have a final temperature of about 366 — 2 = 364 deg. This arrangement gives three-stage heating. If the water passed from heater No. 3 through an economizer and was raised to a still higher temperature by furnace gases at 500 to 600 deg., we should have a four-stage system.

Let us now develop the principle involved in stage heating, the basis of which is the utilization of a portion of the heat contained in the steam in doing useful work before it is applied to the heating of feed water.

In order to simplify the problem we will assume initial conditions that are not usual in practical opera-

tion, and, furthermore, will neglect factors of minor importance that would naturally be included in making accurate computations on a large scale.

In place of the layout shown in Fig. 1 let us take a 1,000-kw. turbine plant using a jet condenser and employing cooling water that is unfit for boiler feeding. Let the entire feed-water supply be taken from the mains at a temperature of 60 deg. and pumped directly to the boilers without preheating. Let the circulating, air, and feed pumps be electrically driven by current taken from the main bus.

Assuming a boiler pressure of 150-lb. gage, the heat required to raise the water from its initial temperature of 60 deg. to that of evaporation (366 deg.) will be absorbed directly from the heating surfaces of the boiler.

For well-known reasons it is not good practice to admit cold water to a boiler, so we will install a heater, corresponding to No. 3 in Fig. 1, and supply it with steam at boiler pressure. A 1,000-kw. turbine, operated with saturated steam at 150 lb. pressure and a vacuum of 28 in., will have a water rate around 20 lb. per kw.-hr., which we will assume in the present case. Assuming the feed water to be raised to a temperature within 2 deg. of the steam, it will require $(364 - 60) \times (1{,}000 \times 20) = 6{,}080{,}000$ B.t.u. per hour. Each pound of steam at 150 lb. pressure will give up 857 B.t.u. in condensing (latent heat), so that $6{,}080{,}000 \div 857 = 7{,}095$ lb. will be required per hour for feed-water heating.

This additional steam which the boilers must produce will require no additional fuel because all the heat abstracted by the additional steam will be returned in the form of hotter feed water (neglecting radiation, etc.). Conversely, there will be no saving of fuel, the advantage being entirely mechanical. This constitutes one form of single-stage heating.

Now let us install a second heater, corresponding to No. 2 in Fig. 1, and an auxiliary turbo-generator, operating the latter non-condensing and turning the exhaust into the second heater, which is under atmospheric pressure and capable of heating water to a temperature of 210 deg.

Let the auxiliary turbine be of such capacity that its exhaust will be just sufficient to raise the temperature of the total normal feed supply from 60 to 210 deg., which requires $(210 - 60) \times 20{,}000 = 3{,}000{,}000$ B.t.u. per hour. Steam at atmospheric pressure has a latent heat of 970 B.t.u., so that each pound of exhaust will give up this amount to the water leaving the heater. Therefore, $3{,}000{,}000 \div 970 = 3{,}093$ lb. of dry saturated exhaust from the auxiliary turbine will be used in heating the feed water through this range. Assuming dry-saturated exhaust, which would approximate actual conditions for a small turbine, and a water rate of 60 lb. per kilowatt-hour, a turbine of $3{,}093 \div 60 = 51.5$ kw. would supply this amount of heat. This also approximates the power required for auxiliary drive in a plant of this size.

Under the first condition, with the live-steam heater No. 3 in use, 20,000 lb. of steam were required per hour for the generation of power, and 7,095 lb. for feed-water heating, making a total of 27,095 lb. to be produced by the boilers from feed water at 364 deg. With the auxiliary turbine in use, 51.5 kw. out of the total load are generated with a water rate of 60 lb. instead of 20 lb. as in the first case, which increases the steam for power purposes $(60 - 20) \times 51.5 = 2{,}060$ lb. per hour.

At the same time the installation of heater No. 2, utilizing exhaust from the auxiliary turbine, has reduced the load on live-steam heater No. 3 to $(364 - 210) \times 22{,}060 = 3{,}400{,}000$ B.t.u. or $3{,}400{,}000 \div 857 = 3{,}960$ lb. of steam per hour. Thus the total demand on the boilers has been reduced to $20{,}000 + 2{,}060 + 3{,}960 = 26{,}020$ lb. per hour, as against 27,095 lb. in the first case, making a saving of $27{,}095 - 26{,}020 = 1{,}075$ lb. of steam per hour by using two-stage heating instead of single-stage.

Going a step farther, we have steam going to the condenser at a temperature of 102 deg., which is capable of raising the temperature of the feed water from 60 deg. to 92 deg. as stated at the beginning of the article, thus reducing the load on heater No. 2 and making it possible to generate a larger proportion of the power by the main unit.

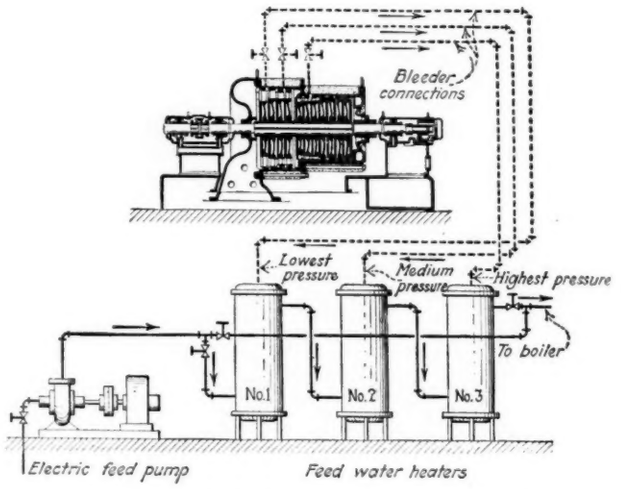


Fig. 2—Heating of feed water by steam bled from three stages of turbine

To raise the feed from 60 deg. to 92 deg. requires $(92 - 60) \times 20{,}000 = 640{,}000$ B.t.u. per hour, or $640{,}000 \div 970 = 660$ lb. of steam at atmospheric pressure. If this demand can be taken from heater No. 2, by placing a closed heater in the exhaust from the main generating unit (see heater No. 1, Fig. 1), the steam to be passed through the auxiliary turbine will be reduced by 660 lb., thus calling for a machine of only

$$\frac{3{,}093 - 660}{60} = 40.5 \text{ kw.},$$

in place of 51.5 kw. as before.

This makes the steam demand for power purposes only $20{,}000 + (40.5 \times 40) = 21{,}620$ lb. per hour, against 22,060 lb. when only heaters Nos. 2 and 3 were in use. Here we have three-stage heating. No further change has been made in the requirements of the live-steam heater No. 3, but part of the work done by heater No. 2 in two-stage heating has been replaced by exhaust from the main unit which was going to waste. The net result of adding the last heater (No. 1) has been to transfer part of the work from the auxiliary turbine to the main unit where it can be done at a lower steam rate, the difference amounting to $22{,}060 - 21{,}620 = 440$ lb. per hour.

No account has been taken of the slight saving in the quantity of raw feed water required, due to the small quantity of condensate going back to the boilers from open heater No. 2.

Comparing the results obtained, we have the following total steam required of the boilers: One-stage heating, 27,095 lb. of steam per hour; two-stage heating, 26,020 lb., and three-stage heating, 25,580 lb. These results are directly comparable because in each case the feed temperature to the boilers is the same.

Stage Heating in Connection with a Bleeder Turbine

Frequently, instead of taking part of the steam directly from the boiler, part from the exhaust of an auxiliary turbine and part from the exhaust of the main condensing unit, electrically driven auxiliary pumps are employed (exceptions to be noted) and the entire quantity of steam required for heating the feed water extracted from the turbine at different pressures, so as to produce much the same results as those herein described.

This arrangement is shown diagrammatically in Fig. 2 and utilizes as much heat as possible in useful work in the turbine before being withdrawn for heating purposes. (In cases of this kind, the term "stage heating" is frequently applied to the process of withdrawing steam from different stages of the turbine rather than to its application in the heating of feed water by stages in a series of heaters. As one process naturally follows the other, there is practically no distinction between the two, but the dual use of the term might be confusing to one not familiar with the subject.) Water can be heated through its lower range by steam at a little above exhaust pressure. Then, by withdrawing additional steam from a higher stage to supply a second heater, the temperature is raised still more, and so on until the final desired temperature is reached.

While increasing the number of stages increases the thermodynamic efficiency of the process, it so complicates the equipment, after a time, that the saving in steam is more than offset by the overhead charges on the extra heaters and piping. In general, two or three stages is about the practical limit, except that a few of the largest stations find it profitable to use four stages.

The highest efficiency is obtained by driving all the auxiliaries by electric motors supplied from the station bus and heating the feed water by steam bled from the main turbine. This follows not only from the reasons already described, but because more energy is extracted from the steam in expanding to a given back pressure in the main turbine than in the smaller auxiliary turbine, or turbines, driving the pumps.

Special Points To Be Considered

The special points to be considered when making a comparison of stage feed-water heating with other methods must include: (1) Saving in steam consumption; (2) relative cost, including installation and maintenance; (3) reliability of the auxiliary drive.

Comparing Steam Economy

The actual saving in steam must be computed for each individual case, as it depends entirely upon local conditions, which vary more or less in different plants. It is safe to say that there is always a gain in steam economy by substituting stage heating with steam bled from the main turbine, combined with electric auxiliary drive over the usual methods employing the exhaust from steam-driven auxiliaries, either alone or combined with live steam. The actual amount of this gain will depend upon the size and efficiency of the main unit, and other conditions relating to the size and type of the auxiliary turbines, general arrangement of heaters, the initial and final temperature of the feed water, etc. With the given data the general methods of calculation are similar to those already described.

A series of curves recently published, relating to a 20,000-kw. turbine, supplied with steam at 300 lb. pressure and 200 deg. of superheat, gives approximately the following results when a comparison is made between stage heating with motor auxiliary drive and the usual method of employing the exhaust from auxiliary turbines.

Final Temp., Deg. F.	Gain in Per Cent
One Stage:	
200	5.2
240	6.0
300	5.0
Two Stages:	
220	6.6
250	7.5
280	7.8
320	7.6
Three Stages:	
250	8.3
280	8.7
320	9.2
360	8.7

It will be seen from an inspection of these results, that with any number of stages the gain in economy reaches a maximum at some final temperature. Furthermore, this maximum temperature is found to increase with the number of stages. The best results were obtained when the total rise of the feed water was equally divided between the heaters or very nearly so.

One point that should always be considered in making a comparison between heating with auxiliary turbine exhaust and steam bled from the main unit, is that the former is practically constant over a wide fluctuation of station load, whereas the demand for feed water varies with the load. This results in alternate excesses and deficiencies in the steam supply to the heater, the former going to waste, while the latter causes low feed temperature and high oxygen content, unless live steam is added, which is always wasteful as previously shown.

When the steam is bled from the main turbine, only the approximate amount is extracted to do the required work under varying load conditions. In operation, there will usually be some variation in feed-water temperature with changes in load, but this is not generally a serious matter.

Comparing Overhead Costs

A comparison of overhead costs can be made only for specific cases, where the cost of equipment in each case is accurately known. As previously stated, the expense increases quite rapidly with the number of heaters employed, and a point is soon reached where the overhead charges exceed the saving in fuel by increased steam economy. In general, three stages is about the limit.

Operating Security

While electric drive for the auxiliary pumps, in combination with stage bleeding from the main turbine for feed-water heating gives the highest economy, it does not produce the maximum security against interruption of service, which is of even greater importance than high efficiency.

It is very important, of course, that there shall be no interference with the auxiliary pumps in case of trouble at the main bus, and this applies particularly

to the boiler-feed pumps. The older method of providing against this possibility was to provide dual drive upon the auxiliary units, motors for regular use and turbines for emergencies.

The next step was the vogue of the house turbogenerator, which may be used in different ways. In one arrangement the pump motors are driven from the main bus and the house turbine held in reserve for emergencies, being thrown into service either by hand or automatically in case of need. Another scheme is to let the emergency generator normally float on the line and pick up the auxiliary load in case of a drop in frequency. The house turbine may be operated as a straight condensing unit, or its exhaust may be used for heating the feed water to temperatures corresponding to steam pressures slightly above atmospheric.

In case the latter arrangement is used, the amount of steam bled from the main unit will be considerably reduced, and consequently the thermal efficiency of the plant, as a whole, will be somewhat reduced.

The object of the present discussion has been to explain the principles involved and call attention to the various possible combinations, rather than to suggest any particular method as being better than any other for all cases. A special study must first be made of the conditions existing in each plant, after which the data presented may be of some use in selecting the most desirable arrangement for the case in hand.

It Often Pays to Discard Good Equipment

By J. A. Madsen

If a little more study were given to power problems in industrial plants, the economies that could be effected would be enormous. Furthermore, the money spent on the necessary improvements would in many cases be returned in a year's time.

For example, in the boiler room of a pressed-steel company steam was generated by two Manning boilers and used by a high-speed engine of 200-kw. capacity and a steam-driven air compressor. The plant ran two shifts from 6:45 a.m. to 10:45 p.m., and the boilers were forced at the highest possible rating all the time, 12,000 lb. of water being evaporated per hour. Natural draft was used most of the time, although there were blowers to help out during cleaning periods. It was the practice when cleaning one fire, to use the blower on the other, and the fire was forced to such an extent at times that flame appeared in the uptake. Naturally, the efficiency was low.

A manufacturer of coal-pulverizing equipment guaranteed a fuel saving of 35 per cent if the company would use their system in connection with a return-tubular boiler in place of the two Manning boilers. A test showed that the efficiency of the old boilers was less than 60 per cent, and the company promised not less than 80 per cent with the new equipment.

The installation cost of the boiler and pulverizing machinery was estimated to be around $10,000, and we calculated that the saving would pay for the equipment in a year or less, as the coal bill was around $100 a day and the coal saving alone was guaranteed to be $35 a day exclusive of any saving we could effect in labor costs. It was decided to set the new boiler seven feet above the bottom of the furnace or combustion chamber to secure the best results. The cost of the boiler with setting was $5,850, the cost of the pulverizing unit was $4,500, making the total investment $10,350. During the first month of operation the coal saving was $840, and we were able to shift one of the boiler-room helpers to another department in the plant, which made a further reduction of $100 a month.

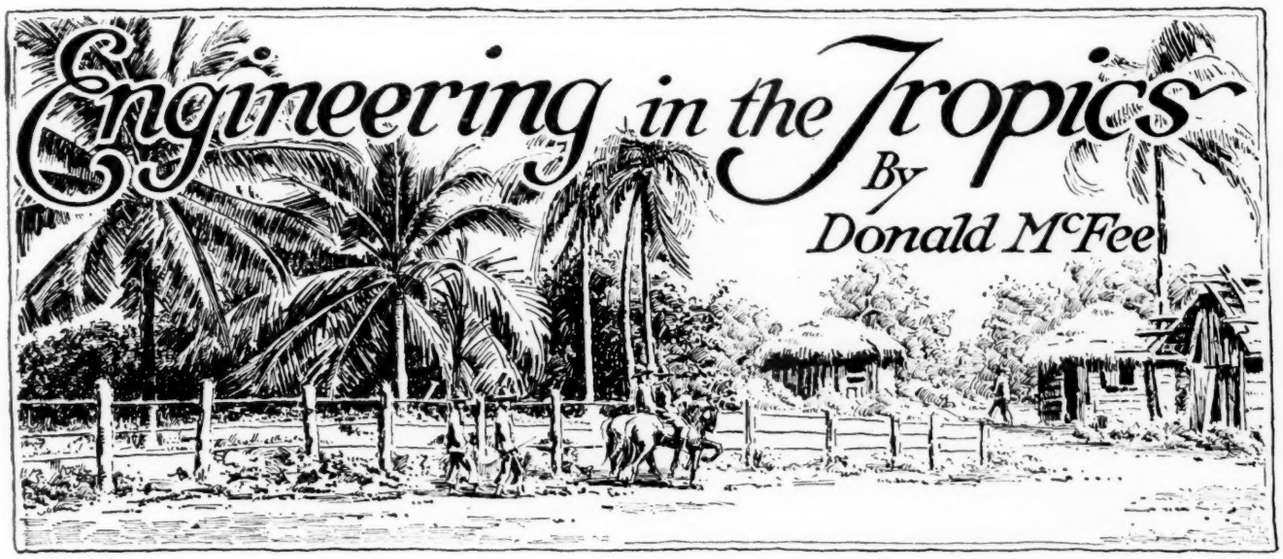
As the boiler was not kept in operation from 11 p.m. to 6 a.m., a method of heating the furnace in the morning had to be devised. The plant contained several gas-fired annealing furnaces, and one of these had been recently dismantled, so we took the burners from it and piped a gas connection into the boiler room. Heating the furnace in the morning took only about fifteen minutes, and the gas bill was increased by about $48 per month. However, this was insignificant when compared with the total reduction in steam-generating costs. The net saving was figured to be in excess of $10,000 a year, after allowing $500 a year for furnace maintenance. An accurate estimate of the fixed charges is rather difficult, no data being available as to the actual life of this class of equipment.

It cannot be expected to secure within the cylinder of an engine or compressor the same kind of film lubrication that can be maintained in cylindrical bearings. There seems to be no way by which a film can be maintained on the cylinder wall thick enough to hold the piston and rings from contact with the wall. A flood of oil cannot be supplied to the wall as is done with a circulatory system for bearings, because the quantity would be enormous and most of it would be carried out of the cylinder at every stroke. Furthermore, if a thick film of oil should be formed, the oil would drain off by gravity, owing to its low viscosity at the high temperatures encountered in steam cylinders. Another thing, piston rings could not be made to slide on a wedge-shaped film of oil, because if they did, they would also leak steam.

When a trap is attached to a piece of apparatus using superheated steam, care must be taken that the steam is not superheated when it reaches the trap, otherwise the latter will not operate. Drips on superheated lines are necessary to handle such conditions as the priming of the boilers. In such cases the connection to the trap must have enough radiating surface to insure condensation for the trap to work on. Traps of the continuous-discharge type and many of the bucket traps require a certain amount of water in the body. If superheated steam gets into the trap, it re-evaporates the water and causes leakage and wiredrawing.

When regrinding an exhaust valve of a Diesel engine it will usually be found necessary to remove considerable metal to get a good seat, so a rather coarse grade of grinding compound may be used at first, finishing up with the fine grade. If the valve is cut or scored too badly to regrind by hand, recourse must be had to the lathe and grinding wheel, as the metal is too hard to be cut by a lathe tool or reamer.

In spite of all that has been said and written on this subject, the alignment of rotating machinery in the average power plant is far from what it should be to insure long life and troubleproof operation, which condition, after all, in the majority of cases can be obtained with small effort and retained at low expense.



YOU ask, "Can an engineer make a fortune in the Tropics?" That depends. But for the every-day man there is no great money below the Tropic of Cancer. Engineers are too lacking in the social graces to marry moneyed senoritas and are too unsuspecting to prevent the business man from getting the better of a deal. Just to prove that let me tell you a tale of my own:

After a year or so in Mexico I found myself short of a job as well as of money, so signed on at Vera Cruz as engineer of a filthy native schooner equipped with a 50-hp. auxiliary oil engine. That she was bound to Venezuela I knew at the time, but later I felt wobbly in the knees when I found that we were smuggling rifles to some revolutionary gang.

It Was Leaving Time

I decided to skip, for I was not keen on rotting in jail, which would be our fate if we were caught. So one night when we were standing outside of the town of Hiqua, I went over the side and swam ashore. I ducked into a dock house and slept until morning, for I didn't dare venture up into the town in the dark. As soon as day broke, I prepared to give the town the once over and had just turned the corner of the building when I plumped into a little Frenchman. Woebegone he looked, although displaying a prosperous state in his clothes. As I was not overlooking any chances as to breakfast, I accosted the sad stranger, but all I could get out of him was the moan, "My heart is broken."

"Pass across a couple of pesos for breakfast just to show you have such an apparatus," I came back at him. "I've fixed many a piece of machinery and am an expert in that kind of pump trouble."

No, I didn't get the touch, but between groans got his story.

It seems that he had decided to install an ice plant in the Tropics and had arrived in Hiqua one morning with the machinery, bent upon creating an ice demand among the rum-drinking natives. Although he didn't know a thing about machinery, by following the instruction book he actually got the plant erected.

"Did it run?" I queried, for it was the first time I ever heard of an instruction book actually telling anything about building or erecting. It did run, and to top it, Frenchie had been busy evenings and had dazzled the daughter of the Mayor of the town.

So far so good, but he continued his wail to say that the Mayor had made a visit to Caracas and on his return had pronounced Frenchie's ice to be worse than no good—so objectionable that he had literally kicked the iceman out of his patio. He flung after him the ultimatum that if good ice was not forthcoming, Frenchie's friends would be buying flowers.

"What's the matter with your ice?" I asked him.

"It is salty, but as long as they didn't know how real ice tasted it didn't make any difference," he said, with a groan.

The word salty aroused my suspicions, and would you believe it, I found that he had been making ice out of sea water. The dry season was on and no one had more rain water stored up than was needed, so he filled his ice cans out of the briny deep. I didn't blame the Mayor for using his foot, but assured Frenchie that we would soon be making real ice.

Becoming a Business Man

I needed a job; my empty pocket and stomach told me that, so I struck a bargain after a lot of dickering. I had never run an ice machine except a ½-ton one on shipboard, but I agreed to turn out real ice in three weeks. He, in turn, was to supply me with eats and, if I did as agreed, was to make me half owner in the plant. I drove a hard bargain, but one must be a business man at times.

We hot-footed down to the shack he called his ice plant, and found it was a corrugated iron affair housing a 15-ton plant along with a 60-hp. engine and boiler to drive the ammonia compressor. The plant looked good and I give him credit for doing a real job with the installation. Without question English manufacturers do know how to mark things, so that anyone can put the stuff together.

I couldn't understand at first why he has used sea water for his ice can when having enough fresh water to run the boiler. I soon found that he didn't do things by halves, for he had been using sea water in the boilers.

The first day I stalled a little to get a chance to

think, so I just took out the boiler manhole cover to look inside. I saw plenty, for there was at least a half inch of salt on every tube. Why that boiler had not already burnt the tubes was a mystery to me.

That evening after eating a typical South American meal at the cleanest hotel, I took a stroll to give the town the once over. I hadn't gone over three blocks when a flower dropped in front of me and as I gave a half-scared jump I heard a little laugh coming from a balcony, just about two feet above my head. Say, she was a peach and while all I dared do was to clap my hands on my heart to indicate I was badly bitten, I finally left feeling I had made a good start.

Business and Pleasure

Next day we cleaned out the boiler and I studied ways and means of getting what good water we needed so badly. If it had been the rainy season, all we needed to have done was to put some guttering on the roof to catch the rain. As it was, somehow I had to make rain water out of the sea.

As near as I could figure, the boiler took more water than was needed to make ice. If I could obtain boiler feed water, a supply of distilled water for the ice was assured. The more I studied the question the more it was evident that an evaporator and a condenser would be necessary.

It was with this mulling over in my mind that I drifted by the balcony that evening. Yes, she was there, and while my Spanish was not high-class I put

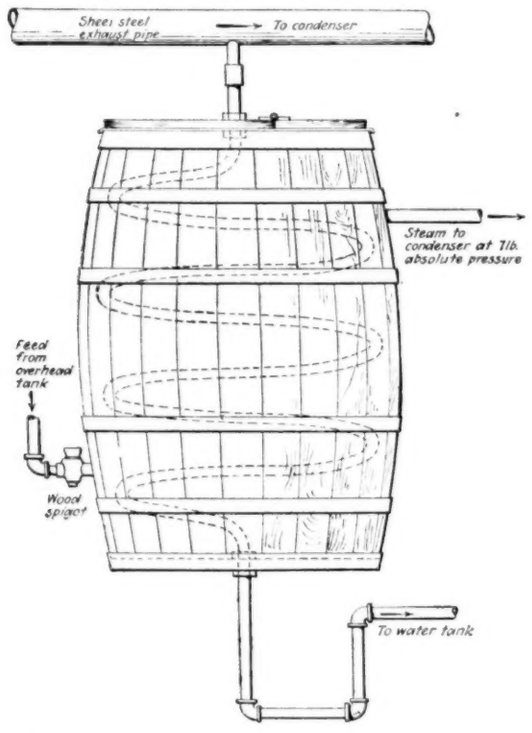


Fig. 1—Barrel converted into an evaporator

over a fine line of conversation. In fact, I spread myself, explaining that I was half owner of the ice plant and that I was the only man in the world who could make it run. That sure aroused her interest and I left feeling I had put in a good day.

The next morning I got down to brass tacks about the water problem. The 15-ton plant would, at its best, make not over 10 tons of ice in 30 hours, or about 700 lb. of water would be needed per hour. The plant would require about 50 horsepower and the water rate of the engine would be about 40 lb. per brake horsepower, or it would need 2,000 lb. of steam per hour to condense for re-use as boiler feed. The problem was then to arrange an evaporator to supply the necessary 700 lb. of distilled water for the ice cans and a con-

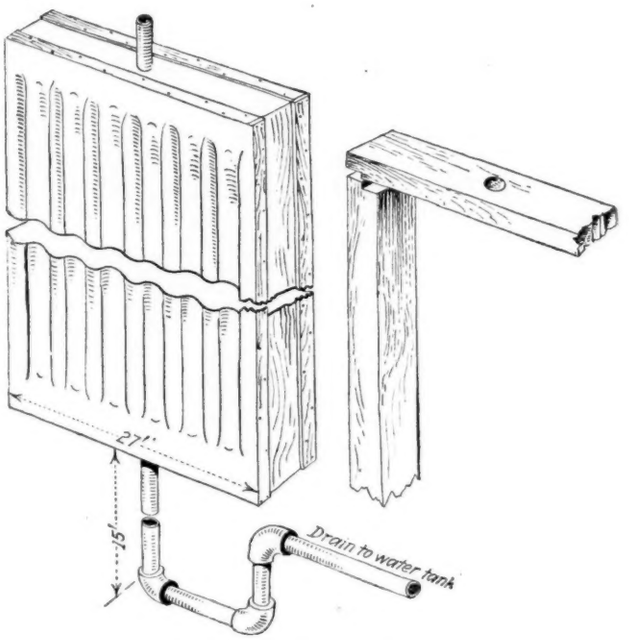


Fig. 2—Corrugated sheeting made a serviceable condenser

denser to care for the steam coming from the engine and from the evaporator plant. I felt that by passing the engine exhaust through coils in some sort of evaporator, we could evaporate enough water to make up that used in the ice cans. Being in a country of simple tastes, only a simple apparatus was possible and this was to be made of material at hand.

Engineering the Job

As I have pointed out, 700 lb. of water was needed per hour, and the heat transfer between steam and boiling water in an evaporator was taken as 300 B.t.u. per hour per deg. of temperature difference, although Frenchie's handbook gave values ranging from 200 to 500. The steam would be at 212 deg. at the least; possibly due to the higher exhaust pressure it might run more than this. The water would come in at 90, and I took 180 deg. as the temperature after evaporation, a rise of 90 deg., for the evaporator temperature would depend on the condenser action. Each pound of water evaporated would require the addition of the difference between total heat of steam at 180 deg. and 7.5 lb. absolute pressure, which amounts to 1,138 B.t.u. and the heat in the water at 90 deg., or 58 B.t.u., an addition of 1,080 B.t.u. per pound of water evaporated; this made a total of 756,000 B.t.u. to be supplied. The average temperature difference between the exhaust steam and the evaporated water would be 212 — 180 = 32 deg.; since only a small amount of the heat would be applied to the water before it reached 180 deg., I used only the two steam temperatures of my calculations. The surface of heating coils in the evaporators then

figured out 756,000 ÷ (32 × 300) = 79 ft. (approx.). In evaporating this 700 lb. of water 756,000 ÷ 970 = 779 lb. of exhaust steam would be condensed.

We had quite a stock of 1¼-in. pipe, and 2.75 lin.ft. of this pipe has an internal surface area of 1 sq.ft. We needed 79 × 2.75 = 217 lin.ft., but to be safe I decided to use 12 lengths, or 240 ft.

We picked up 12 oak barrels and after heating the pipe coiled it so that the coils would fit into the barrels. Each coil had one end passing through the bottom of the barrel and the other end extending through the top, which we held down with stones, using a cloth around the edge to steam-seal it. To drain off

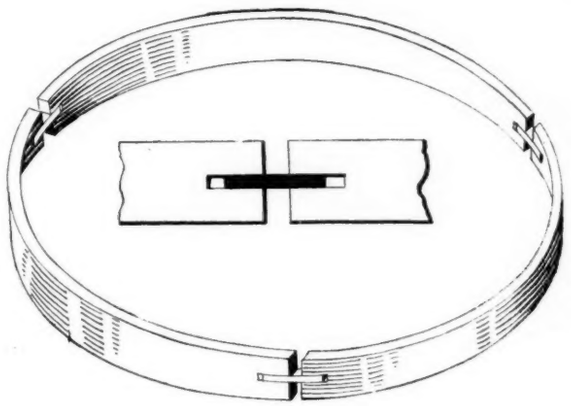


Fig. 3—How broken rings were used again

the salt solution when it became too concentrated, a bung was placed in each barrel.

The sight of the 12 little nipples to take some 700 or 800 lb. of steam out of the exhaust pipe made me feel that the area of these pipes was too small. In working it out I found that at atmospheric pressure each pound of steam would occupy a volume of approximately 26 cu.ft., or a total of 20,254 cu.ft. entered the evaporator per hour. This meant that each coil must pass 1,680 cu.ft. per hour; the 1¼-in. pipe area is approximately 1.5 sq.in., making the velocity (1,680 × 144) ÷ 1.5 = 161,000 ft. per hour; this is less than 3,000 ft. per min., a low steam velocity.

It is necessary to seal the bottom connections to keep the atmospheric pressure from backing up into the coils and prevent the entrance of the exhaust steam. This called for a loop or U-tube at the coil drain end.

Catching the Heat Units

I figured that, roughly, a condenser ought to remove 200 B.t.u. per hour per square foot of surface per degree of temperature difference between the cooling water and the steam. The water would have an intake temperature of about 90 deg. and an outlet of, say, 140, making an average of 115 deg. If the steam was at atmospheric pressure, its temperature would be 212 deg. F. The average difference between the steam and cooling water would then be 212 — 115, or 97 deg. F., or 100 deg. in round numbers. This would give a heat transfer of 200 × 100 = 20,000 B.t.u. per sq.ft. of surface per hour. I had to condense 1,220 lb. of exhaust steam at 212 deg. F. and at atmospheric pressure, which calls for the removal of 970 B.t.u. per lb., or a total of 1,183,000 B.t.u. per hour. If I could remove 20,000 per sq.ft., I needed 1,183,000 ÷ 20,000 = 59 sq.ft. of condenser surface, and since the condensed steam needed to be cooled a few degrees below 212, surely 65 sq.ft. would be ample. To receive this heat we would need 23,660 lb. of water per hour.

As I have explained, the evaporator was to be under 7 lb. absolute pressure, and it was necessary to have the condenser shells handling this evaporator steam at a pressure under 7 lb. absolute and separate from the shells handling the engine exhaust at 15 lb. absolute. The temperature of the evaporator steam would be approximately 170 deg. F. The cooling water would go in the condenser at 90 deg., and I assumed a leaving temperature of 120 deg., a rise of 105 deg. and a mean temperature difference between the steam at 170 deg. and the water at 105 deg. of 65 deg.

The 756,000 B.t.u. to be removed from the evaporator steam would call for a heating surface of 756,000 ÷ (200 × 65) = 58 sq.ft., approximately, making the total surface 123 sq.ft. The cooling water would total 756,000 ÷ 50 = 15,120 lb. per hour.

Steel Roofing Solves Problem

In rambling around the town I ran across a big shipment of corrugated steel roofing, and this suggested that plate condensers could be made by fastening two of the sheets together, passing steam inside and letting the cooling water flow outside. These sheets were 6 ft. long by 30 in. wide and allowing 3 in. all round for the joint two plates would give 2(60 × 27) ÷ 144 = 22.5 or, say, 22 sq.ft. I would need about six such condensers so promptly annexed twelve of the sheets, telling the dubious owner that Frenchie would settle with him.

To make up the condenser shells, we flattened the corrugations at the ends of the sheets and made a frame of 6x6-in. timbers, nailed the sheets on each side to form a hollow box. These boxes were connected by light nipples to the engine exhaust, which we made up of rolled sheet roofing.

A native coppersmith riveted the piping together and then soldered the lap enough to prevent much leakage. It was the idea to let the condensate drain from the bottom of the shells, so use was made of some of the nipples and pipe Frenchie had not needed.

Putting in the Good Licks

All the work had to be done with the help of native labor. Frenchie had the habit of showing up each morning bubbling with enthusiasm, but about 9 o'clock he would disappear to be seen no more that day. The rest of the time he spent around the cafés, expanding upon how he was rebuilding the ice plant and upon the wonderful ice to be produced. I had no objection to his enlarging on his part in the work, as I was satisfied to become a part owner, and of course I was not neglecting the balcony in the evenings.

The condenser tanks we hung on a wooden framework as close to the shore as possible. To obtain cooling water, a bucket elevator pump to lift the sea water and put it over the condenser was necessary. This conveyor belt was made of a lot of drilling cloth such as is used by the natives for clothing. We would take a bolt of the goods 36 in. wide and fold it until the strip was only 12 in. wide, a native woman sewing several of these into a thick belt. For the buckets I sent a native to scour the town for empty 5-gal. kerosene cans. These were first cut down to hold about a gallon of water and then bolted to the belt, and after making up wooden belt wheels to turn on wooden

bearings, a serviceable bucket elevator resulted. We concluded that if each of the cans would hold one gallon, the conveyor would be called upon to lift approximately 77 buckets per minute, and allowing 20 per cent loss by spilling, plus an additional 25 per cent for the water that might splash off the condensers, 140 would be needed per minute. We found that the buckets had to be placed 1.5 ft. apart to give clearance, which made the minimum elevator speed 210 ft. per minute.

With all the apparatus set in place, it looked as if we would be able to start the next day. Of course Frenchie was excited, I was myself, and he at once ran off to tell that girl of his that everything was lovely. When I arrived at my balcony, I felt that women gossip in the Tropics as elsewhere, for Juliet, as I called her, knew that we could soon be making ice. She encouraged me to get the plant going, and I left feeling that such interest indicated that she was not indifferent to me.

Compressor Lies Down on Job

I had been too busy to look into the compressor, and as luck would have it, when we turned her over, she would not pump. I could hear the ammonia gas blow down along the piston and it was plain that piston had to be pulled. On breaking connections and lifting off the head, it was found that the piston rings were all broken. Of the four there was not an entire ring, but each groove held from three to a dozen pieces. To repair this looked like an impossible job. There were no extra rings on hand and nowhere to get them. I rummaged around in my brain and discovered an idea. Enough of the larger pieces were taken to make up a complete ring, three pieces being necessary. These were sawed so that the ends carried a slot into which was inserted a brass plate or key to tie the adjoining ends of the pieces. This ring was to go into the top groove and into the other grooves babbitt fillers were run. The piston was then slipped into the cylinder and the babbitt scraped until it fitted nicely.

Finally five cakes of ice were produced, and you ought to have seen Frenchie throw out his chest as he pranced uptown to tell everybody he was making real ice. We didn't get anything for the cakes, for Frenchie used them up in sending chunks to about everybody in town. I held out a small piece to take with me to the balcony, but when I drifted up that evening there was a chilliness in the air not all due to the hunk of ice under my arm.

Disillusionment

Coming down to get a drink in the café, I bumped into Frenchie, who was all dolled up. He was in a hurry, he said, being on his way to a ball at the Independence Club. After consuming a few cool drinks, I drifted down the street toward the club, which was aglow with lights. The doors and windows were all open and the sidewalk was crowded with peons gaping at the beautiful ladies. I stopped dead in my tracks, for just as I passed one of the wide windows, who should I see but Frenchie dancing with my girl in his arms. Sure, I was sore and more so when some old fellow, who I guessed was her father, came up to them with a sort of God-bless-you my children look on his face, and congratulated Frenchie on the wonderful result of his noble efforts of getting the ice plant to run. And the way the girl looked at Frenchie, I knew my goose was cooked. Evidently, I had been courting the Mayor's daughter, and she, being Frenchie's girl, had kidded me in order to get the plant going.

"Well," says I to myself, "I may have lost my girl but I'm half owner in a darned good business."

With that, I went to bed, for I was dead tired. I had been asleep about an hour when someone banged on the door. It turned out to be Frenchie with three guardie, or policemen. Frenchie explained that they, the policemen, were there to give me protection, for the Mayor had heard there was a plot to kill me. A schooner was sailing that night and he thought it would be best for me to skip on board before the plotters stuck a knife between my ribs. I wanted no protection and could take care of myself, but despite my kicking, the policemen propelled me downstairs and along the silent streets to the dock. Here was a gig into which I was half thrown, and the sailors pulled toward the schooner anchored at the harbor mouth. I was inclined to fight it out, but there were too many.

So I sailed out of Hiqua a good engineer but a bum Romeo and a poor business man. Yes, there is wealth in the Tropics, but not for an engineer.

Quieter running of a motor-driven compressor is obtained by "running under"—that is, when the crank falls in the beginning of a stroke from the cylinder toward the crankshaft—for then the alternate thrust and pull of the connecting rod, as well as the weight of the crosshead, bring the pressure of the crosshead on the lower guide. In a steam engine, where the power is transmitted from the crosshead to the crank, pressure is brought on the lower guide and quieter operation is obtained by "running over." By "running under" in case of a motor-driven compressor, or "running over" in case of a steam engine, there is better opportunity for lubrication of the guide that receives the principal wear, better opportunity of adjusting and maintaining alignment of the crosshead and less tendency of the crosshead to pound on the guides.

Soldering fluxes may in general be divided into two classes, corrosive and non-corrosive. The corrosive mixtures are sometimes termed acid fluxes, from the fact that they usually contain an acid in their composition. The non-corrosive fluxes, of which tallow and resin are examples, are those that do not react chemically with the copper. Their purpose is simply to reduce the oxide coating on the metal so that the solder may obtain intimate contact with the metal. A corrosive flux may be easily distinguished from one that is non-corrosive by coating a clean piece of copper with the flux and observing whether it is discolored after a week's time.

Other gases than air are found in the ammonia system, in small or large quantities. Ammonia as purchased is not pure. When it contains many impurities, it leads to various troubles. Tarry deposits may separate and collect in the pipes. Other impurities decompose into various gases, especially under the action of heat.

There are many causes for gas engines failing to pull their rated load, but they may be brought under about four general classes, namely, leakage, faulty or improper valve and ignition timing, and overheating of the cylinder and piston with consequent faulty lubrication.

Getting It Across

THE complaint is common that engineers as a class do not get the recognition warranted by their knowledge and practical abilities. Often the glib talker, with but little knowledge (except perhaps of human nature), gets his ideas or propositions accepted, while the engineer—the man who really knows what should be done—is left out in the cold.

The operating engineer, for example, frequently fails to obtain much needed equipment for his plant, because the owner or manager will not act on his suggestions. Nor does his professional brother often get as much attention as the lawyer or politician when engineering matters of political interest are up for public discussion.

These are the well-known facts. The explanation is obvious. Engineers, as a class, lack that skill of speech and manner which so distinguishes the true salesman. The pity of it is that they have something worth "selling"—an intimate knowledge of the machinery that keeps the world turning. Human nature being what it is, merit alone is not enough; one must generally have some skill in persuasiveness if he is to get his due. This skill, like any other, comes only with study and practice. The engineer will never get the recognition he deserves until he takes this matter as seriously as he does his machine.

Are Welded Pressure Tanks Safe?

THE suitability of welded tanks for unfired pressure vessels is discussed in the September issue of *Labor and Industry*, issued by the Pennsylvania Department of Labor and Industry. John S. Spicer, chief of the Accident Investigation Section, Bureau of Inspection, says that many failures of air receivers during the last few years, and particularly during the last few months, have convinced the officials of the Department that regulations are necessary for the construction of unfired vessels.

Pressures often equal those found in boiler installations, but construction has never been given the attention that the use requires. He states that the rupturing of welded tanks has conclusively demonstrated that unfired vessels require regulations such as are required for fired pressure vessels. The Department has heard of no recent failures of riveted tanks under similar conditions.

The question now uppermost in the minds of the officials of the Department is whether a welded tank is suitable where pressure is to be applied, and if so, what regulations should cover its construction and use. Admitting that there is no doubt that a welded tank, properly constructed, will stand up, he points out the great difficulty of determining by inspection that the workmanship of the weld has been properly performed. Unless a hydrostatic test is made in excess of the working pressure, it is not safe to use a welded tank.

The Department invites constructive criticism upon the matter, and *Power* will gladly serve as a medium of exchange between its readers and the Department.

The Rules for the Construction of Unfired Pressure Vessels, of the A.S.M.E. Boiler Construction Code, impose conditions more severe, if anything, than those suggested by Mr. Spicer. Only the smaller sizes of tanks may be welded, and with the exception of enameled tanks they must be subjected to a hydrostatic pressure test at one and one-half times the maximum allowable working pressure (never less than fifty pounds per square inch above the working pressure), and in addition a severe hammer test is required. Air receivers must then have the pressure raised to three times the maximum allowable working pressure, and held there for three minutes.

Pennsylvania has adopted the A.S.M.E. Boiler Construction Code. Can they do better than adopt Section VIII for Unfired Pressure Vessels?

Industrial Research

AMERICAN industry is becoming more and more dependent upon research. This may be reflected in entirely new devices, improved products to meet changing conditions, the elimination of waste in production or even in the more commercial aspects of marketing. Whatever the application, the gap between pure research and applied engineering is becoming less, and it is now essential for most purposes that the research man possess an appreciation of production methods and sales problems; moreover, he must gain the confidence of the production department.

Things are moving so swiftly that the concern or industry that is content to rest on its oars is likely soon to find itself outdistanced by competitors or its product rendered obsolete by the appearance of some entirely new device or process. On the other hand, investigations inspired to meet certain definite problems may be productive of results that will open up entirely new fields of application. Instances of both kinds were brought out in a recent discussion before the Engineers Club of Philadelphia.

In the power-plant field the problem is especially pertinent, owing to the rapid advances in practice. Not only do many of the large power companies maintain research staffs that are constantly studying operating problems, but many manufacturers of power equipment are finding it necessary to maintain such departments which are doing most creditable work.

Special designs based merely on personal preferences of the purchaser are quite a different thing from those based on sound research tempered by manufacturing and marketing experience. The former are

likely to be costly without serving any real purpose, while the latter not only tend to place the manufacturer in the lead, but are often reflected in reduced manufacturing costs.

That research has established its claim as an adjunct to industry is beyond question. The job is there to be done. Are the men available to do it? Some of the leaders in this work have recently expressed the opinion that our colleges are not living up to their opportunities in training men for industrial research; in other words, they are not turning out men who combine the technic of research with a vision of the production and economic problems involved. This charge may or may not be wholly true. Nevertheless, it is of sufficient importance as to warrant careful study.

Both Are Responsible

THE operating engineer is frequently accused of various shortcomings some of which may or may not be deserved, according to the individual; but how about the management that employs an incompetent man? Has not the man who controls the purse strings some responsibility in the operation of his power plant? If a manager takes the attitude that the power plant is a source of expense and the only way to avoid expense is not to allow the engineer to spend any money on improvements, is he to be regarded as highly competent and efficient and the engineer who made the suggested improvement to be regarded as anything but what he should be? Can the executive who takes no interest in the operation of his power plant expect the engineer to do his best work when left entirely to his own initiative?

In the operation of the power plant the responsibility is the engineer's, but in the final results it is largely up to the business management. This does not mean that the manager must know all about the plant's operation—that is the province of the engineer—but he should know the amount of fuel burned, steam and power produced, their cost and how used, along with a comparison of the same period for the preceding year and preceding month. A monthly report showing nothing more than this will give a good idea of how the plant is operating. From this report a check can be made on the cost of the power and steam per unit of manufactured product.

In an organization doing a sixty million dollar business annually, the president is on speaking terms with the chief engineer in his power plant. That plant stands out as one of the most efficiently operated in the country. A brief monthly report of the power plant's operation goes to the executive officers of the company each month and annually. These officials have learned that by employing a competent engineer and co-operating with him, instead of being a bill of expense to the business, he is a medium through which thousands of dollars are saved. In fact, in this particular business it is figured that the annual saving in the power plant due to good operation has amounted to more than the net profits of some of the large departments in the business. This way of looking at the power plant is worthy of serious consideration by business executives. If the profits made in one department of a business can be lost in the power plant by improper operation, why not keep the plant in order and have two profits instead of only one and lose that?

Welded Piping Installations

PRESENT indications point to a great future for welded pipe lines in the power plant. Already a considerable amount of pipe welding is being carried on by the fabricators in their shops and on the job. In addition many power plants—particularly the larger ones—keep one or more welders busy most of the time on extensions and repairs.

It would be a mistake to conclude hastily that the whole profession is now "sold" on the superiority of welded lines. Many engineers still question the safety of welded joints for high pressures and temperatures. For such work the Van Stone joint is now standard, although the increasing use of the Sargol joint (in which the weld acts as a seal only, while the bolts carry the strain) might be regarded as the first step toward the all-welded job.

It has been demonstrated that welded joints—simple butt welds at that—*can* be made safe for high steam temperatures and for pressures of three hundred pounds and higher. One of the largest organizations engaged in the fabrication and erection of piping systems is willing to erect welded lines for such conditions and guarantee their safety. At the same time it is recognized by all conversant with welding that the human element is the determining factor in the dependability of a weld. Welders for high-pressure jobs must be carefully selected and trained.

It is fully realized that any failures of high-pressure jobs, even though due solely to incompetent welders, would give welding a setback. In the high-pressure field, therefore, progress will be gradual and dependent largely upon the skill with which the personnel problem is handled.

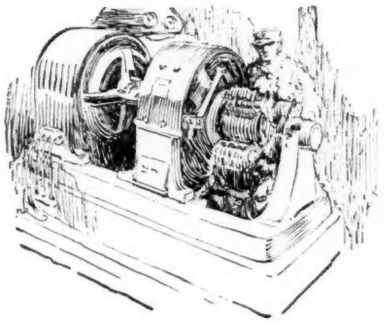
The welding of lines for low and medium pressures, on the other hand, is now common and gives promise of an enormous growth in the next few years. Already there are many such jobs available for inspection.

The admitted advantages of welding, such as convenience, better appearance, elimination of gasket leaks and replacements, reduction in heat losses, lowered cost of heat insulation, adaptability, reduced weight, etc., along with lowered first cost, make it a matter of vital importance to every engineer and explain the general interest now being shown.

Something goes wrong in the plant, or you see room for some improvement. A happy thought, an ingenious idea, or perhaps just hard thinking and continued experiments solve your troubles. Other engineers will encounter the same or similar problems. Give them the benefit of your experience, as you have profited by theirs. Tell it to your co-workers in the local association of engineers. Write a letter to your technical journal, inclosing a sketch or photograph if necessary to make your explanation clear. Pool your experience with other engineers and share in the resulting advance of industry in engineering.

In *Le Génie Civil* for October 10 and 17, G. Delanghe discusses the ultimate possibilities of steam cycles. He believes the highest attainable efficiency to be about 36 per cent (less than 10,000 B.t.u. per kilowatt-hour), with steam at 1,250 lb. per square inch, and 900 deg. F., reheated twice during expansion, and extracted for feed-water heating in eight stages. Might not a consideration of plant costs modify these conclusions?

Practical Ideas from Practical Men

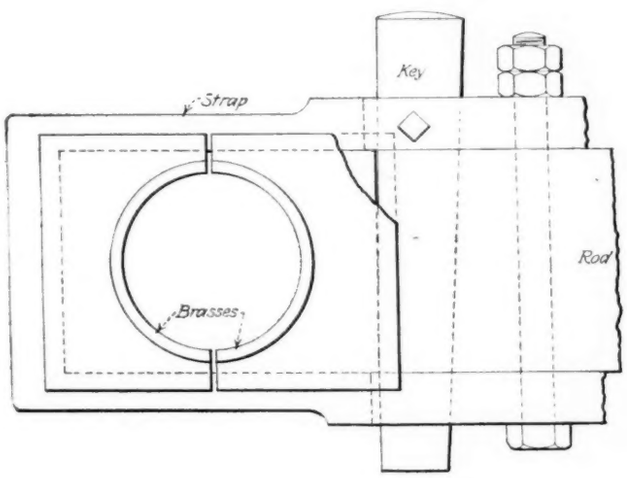


WITH a view to stimulating engineers into the habit of recording for the benefit of brother engineers, unusual occurrences, how these were met and other practical expedients adopted in the operation of their plants, Power has decided to award two cash prizes each month during 1925. One of $25 for the best and another of $15 for the second best practical letter on plant operation or practical kinks received during the month. This is in addition to payment for the contribution at space rates. The winners for September will be announced this month.

Improperly Fitted Key Causes Knock in Crosshead

Upon taking charge of a plant recently, I found one of the engines, a 14x20-in. slide-valve unit, had a severe pound on the crosshead pin. As the engine was required to run about 21 hours out of the 24, no work to amount to anything could be done on it until the following Sunday.

During the week I applied the indicator, which revealed practically no lead or compression, and I felt sure I had hit upon the trouble, but after adjusting the valves until a good diagram was obtained, the pound remained about as usual. The crosshead pin box was of the strap and key type, and everything I could possibly think of was tried without results. The brasses appeared to be a shade loose for the strap, so measurements were taken and new brasses made. When these



Key did not fit properly against brasses

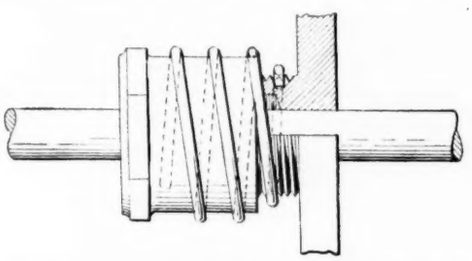
were put on, they fitted perfectly, but the following Monday morning, when the engine was started, the pound was there as usual.

The following Sunday I took the strap, brasses and key off, then obtained a piece of pipe that finished up to the size of the pin and carried all to a well-lighted work bench and assembled the parts. As soon as I tightened up on the key, the trouble was apparent. The key did not have the proper taper for the slots in the strap, which caused it to make contact only with about two-fifths of the back of the brass, as shown in the illustration. After some filing the key was made to fit perfectly against the back of the brass. When the engine was again started, the knock had disappeared.

Allison, Ala. F. D. HEWLETT.

Preventing the Packing Nut from Loosening

When adjusting the packing on a pump or steam piston rod of an old unit, our practice is to set the nut just a little tighter than we believe the packing really needs to be forced to. This is because the threads on



Spring prevents packing nut backing off

the nut and the stuffing box are worn, and the nut would be loose only that the resistance of the packing pushing against it holds it tight. But as the packing wears, the nut becomes loose and tends to work off. Giving it an extra turn seems to develop in one's mind an idea that it will remain tight just that much longer.

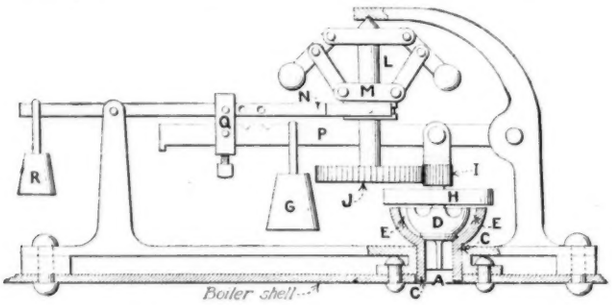
To hold these worn nuts in place, a coil spring may be formed to fit the base of the stuffing box and the packing nut. This spring is wound left-handed and the end of the wire at the inner end of the spring is bent at right angles to fit in a ¼-in. diameter hole drilled at the base of the stuffing box.

The first coil of the spring is formed the size of the threaded part of the stuffing box so as to hold the projection in the hole, and the rest of the spring, consisting of four or more turns, is made to fit snugly on the nut. As the nut is turned on to tighten inside the spring, the latter is expanded sufficiently by its gripping the nut to allow it to be tightened, but as the nut attempts to loosen the spring contracts and grips it, preventing its backing off. To remove the nut when new packing is required, the tip is lifted out of the hole with a pair of pliers and the spring allowed to turn with the nut. G. G. MCVICKER.

Safety Valve Patent of 1853

While looking through the United States Patent Office record for the year 1853, I came upon an old safety-valve patent, a description of which might prove interesting to *Power* readers.

The patent was granted to one Zadok H. Mann, of



Old-time safety valve with governor attached to insure promptness of action

Cincinnati, Ohio, Sept. 13, 1853. The record reads as follows:

IMPROVEMENT IN SAFETY-VALVES FOR STEAM BOILERS

This invention has for its object, to insure the opening of the valve at the desired time, of the maximum pressure; and also, so as to increase the size of the opening in proportion to the force of the steam, and thus insure an adequate vent for the steam under all circumstances, and thereby remove all danger or possibility of explosion.

A, is the boiler; *EE*, channels for the steam to escape, formed by the cup-like rims of the valve *D* and its seats *C*. *I*, is a pinion, and *J*, is a spur wheel, which transfer rotary motion to the governor *L*, whose s'eeve *M*, is connected to lever *N*. Lever *N* is connected with lever *P* by link *O*. Link *O* can be fastened to any one of the holes in lever *N* by the pin *Q*, in order to determine how much play of the balls shall lift the valve; *R* balances the governor, *H* is the flutter wheel.

CLAIM

The construction and application to a safety valve, of flutter wheel, governor and supplementary lever, or equivalent devices, in order to insure promptness of action and increase the vent, according to the force of steam, with or without the adjustable link and counterweight.

The foregoing is just as it appears in the record, no changes have been made in language or punctuation.

North Canton, Ohio. E. W. BRONG.

Welding on Boilers

In view of the ever-widening applications of fusion welding throughout industry and the probability that repairs to boilers made in this way will be proposed from time to time, it is well that those responsible for the results should bear several points in mind. For simplicity, these are listed briefly as follows:

1. Most boilers are insured.

2. Many boiler-insurance policies are so worded that if repairs are made without the authority of the company carrying the insurance, the policy becomes void.

3. There are federal, state and municipal regulations governing this work, as well as those issued by the insurance companies.

4. Only competent welders, used to boiler work, should be allowed to do the welding.

Therefore, the following precautions should be observed by the owner or his representative:

1. Examine the part of the boiler to be welded in company with the insurance company inspector, and get his approval before doing any welding.

2. Be present at the test after welding with the inspector.

3. If possible, get the inspector to sign a statement that the work has been properly done and that it has passed the test successfully.

4. If the boiler is not insured, and comes under federal, state or municipal supervision, carry out the foregoing program in company with the proper authority.

If the boiler is neither insured nor under supervision of some constituted authority, ample precautions should be taken by the welder and the owner to protect themselves against possible future trouble. They should make a sketch of the location and size of the repair, with a clear statement of what was found wrong and how the repair was made. They should always make a hydrostatic hammer test of the finished job, using a pressure of 1½ times the working boiler pressure, in the presence of witnesses, and get their signature to a statement of the facts. These papers should be carefully filed away. In such a case no welding should be done which is not permitted by law or by good practice.

In case of marine work the welder should pass the regular examination of the Federal Steamboat Inspection Service.

In all cases the welder should make friends of the insurance and other inspectors by refusing to do work unless authorized by them, by being conservative in what work he recommends and by doing nothing except a first-class job.

S. W. MILLER,
Past-President American Welding Society.
Long Island City, N. Y.

Steam-Driven Auxiliaries Are Wasteful

The importance of securing the most economical drive for auxiliary equipment has been recognized by public-utility plants, small non-condensing steam turbines being replaced by electric drive. Steam for feed heating is obtained by bleeding the lower stages of the turbine. Since this method extracts over twice as much power from the steam required by the feed heaters without reducing the feed temperature, it is generally recognized as an advance over the older method.

In industrial plants no such close study has been given this matter, and there are hundreds of plants where the steam consumption of auxiliaries frequently is as high as 50 per cent of the main unit steam consumption. There are two reasons for this condition. The most efficient drive for the auxiliaries has never been considered, and many industrial plants have relatively more auxiliary equipment than has a central station. In addition to feed and condenser pumps, exciters and fan engines, they have air compressors, process water pumps, elevator pumps and even small ice machines. All of these are usually steam driven in the older plants and have water rates around 40 to 60 lb. per hp.-hr. The main unit is either a condensing turbine or compound engine in plants of 1,000 hp. or over, and the auxiliaries furnish exhaust steam enough to heat the buildings in winter, the exhaust going outboard in summer except the small quantity needed to heat the feed water.

Many plant engineers and even a few well-known

designers consider that as long as this exhaust does the heating during winter months, it is not advisable to spend any money trying to reduce the cost of the auxiliary power. In cases where the steam from auxiliaries suffices for the heating requirements in winter and the main unit operates condensing the year round, a little study will reveal the fact that large savings are possible.

Take the following case as being typical of industrial conditions: A 1,000-hp. compound condensing engine with a water rate of 13 lb. per hp.-hr.; feed and condenser pumps of the direct-acting steam type with a rate of about 60 lb. per hp.-hr.; 20-hp. air compressor with a rate of 48 lb. per hp.-hr.; elevator and service pumps totaling 30 hp. at 60 lb. per hp.-hr.; a 10-hp. steam-driven ice machine with a water rate of 50 lb. per hp.; and a 15-hp. fan stoker and fan engine at 50 lb. per hp., the average for the two being 62 lb. per horsepower-hour.

The feed and condenser pumps will use 1,000 lb. of steam per hour, air compressor 960 lb., other pumps 1,800 lb., ice machine 500 lb., fan and stoker drive 930 lb. and the main unit 13,000 lb. per hour, making the total flow 18,190 lb. per hour. These figures apply to a plant in this vicinity and show the steam consumption of the auxiliaries to be over 39 per cent of the main engine requirements, while only 92 hp. is developed on this steam, or 9.2 per cent of the main engine output.

If electric drive is applied to these units, the steam required for power and feed heating and for heating buildings in winter can be furnished in two ways. The correct method is to secure all power from the main engine and bleed the receiver for the heating steam, provided this engine is not already overloaded. The alternative is to install a unaflow engine to operate in winter and generate all the power possible on the steam required for heating, which would reduce the load on the main engine considerably.

If the first method is followed, the auxiliary power is developed in the high-pressure cylinder of the engine and steam is bled at about 10 lb. for heating. Assuming the feed water to be taken from the condenser at 120 deg. and heated to 210 deg. in an open heater, the steam bled in summer will be about 1,250 lb. per hour. Without bleeding, the engine would use 1,092 $\times$ 13, or 14,196 lb. per hour, and when bleeding 1,250 lb. would require the admission of 625 lb. at the throttle, so the final steam flow is 14,821 lb. per hour, or a reduction of 18.5 per cent in the total steam flow. Assuming that the heating load in winter consumed 80 per cent of the auxiliary exhaust, the amount to be bled in winter is 4,152 lb. per hour. Now since about 50 per cent of the amount bled must be admitted at the throttle to carry a given load, the steam consumption is 16,272 lb. per hour, showing the reduction to be 10.65 per cent in winter.

The average reduction in steam flow the year round is practically 14 per cent, and as this plant runs day and night for 305 days with a fuel consumption of over a ton an hour, at $6.50 a ton the annual saving would amount to $6,661 per year. No allowance is made for the reduced amount of steam needed by the feed-water heater or the possible reduction in boiler-room labor due to the reduced load. If motors can be applied to the air compressor, ice machine, fan and stokers, and motor-driven pumps substituted for the steam pumps at an average cost of $70 per hp., the total cost of changing over would not exceed $6,340. As the annual fuel saving exceeds this figure, a return of over 100 per cent on the investment is possible.

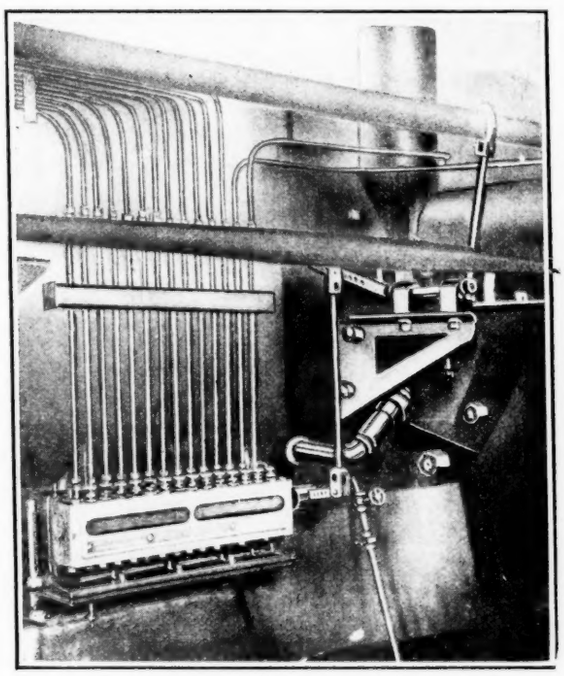
This is by no means an extreme case. In fact, there is a plant in this state built about 10 years ago at a cost of $400,000, where according to meter readings the steam flow to auxiliaries with a total horsepower of about 150, is never less than 10,000 lb. per hour, while the main turbine of 1,250 kw. capacity carries full load on 15,000 lb. per hour. The main unit in this plant could generate the auxiliary power on 2,000 lb. per hour, and the possible savings here are double those in the first-named plant. Any steam needed for feed-water heating or any other low-pressure process could easily be extracted from the lower stages of the turbine, as not over 5,000 lb. per hour is used at any time.

Indian Orchard, Mass. M. BUCKLEY.

Arranging an Oil-Pump Drive on a Large Compressor

Some time ago we purchased a fourteen-outlet force-feed oil pump for a large tandem two-stage air compressor, and the question came up as to the best location for the pump on the engine and the best method of driving it. To drive the pump from the crankshaft would necessitate long and winding oil-pipe leads, so it was considered more practical to locate the pump in a central point between the cylinders.

In order to do this and have the pump convenient to look after and still not be in the way, it was found necessary to drive it from one of the reach rods to the valve rocker arm. The pump had to be placed below the reach rod and at right angles to it. As the rod moved in a horizontal plane while the pump arm moved in a vertical plane, it was necessary to add a small auxiliary rocker shaft and make two connections in the vertical drive shaft to the pump. The illustration shows how this was done and is self-explanatory.



Method of driving pump

Sewickley, Pa. L. M. JOHNSON.

Comments from Readers

Measuring Coal on Traveling-Grate Stokers

With reference to the letter by M. J. Evans in the Aug. 18 issue discussing my comments in the June 16 issue on Mr. Darnell's contribution entitled "Measuring Coal on Traveling-Grate Stokers," Mr. Evans mentions certain facts which, in his opinion, prove that the use of a revolution counter as a coal meter is good practice.

Relative to the scope of usefulness of the daily determination of the amount of coal consumed, no such measurement, however made, can be used in figuring the cost of power. That item must take into consideration the actual amount of money paid for coal, including freight, taxes, handling, etc. But the boiler-room operator or the boiler cannot be held responsible for the loss of coal in transit or the increased rate of transportation and handling. They are, however, accountable for the most efficient utilization of the coal delivered to the plant, and the daily determination of the amount of coal consumed and the amount of water evaporated at each shift, by each boiler will readily show any falling off in efficiency. This check and the fixing of the responsibility for waste and rewarding for efficiency cannot fail to bring up and maintain a plant at its maximum efficiency and indicate where improvements are possible and practicable. This and not the furnishing of data for the power cost statement, is the object of determining the coal consumed by each boiler on each shift. And here is where its usefulness terminates.

Mr. Evans' contention that the measurement of coal on a traveling-grate stoker is analogous to the discharge of a liquid over a weir only sustains the old maxim that analogy is no proof. While a granular material apparently possesses certain characteristics of a liquid and superficial observers insist that it may be considered as such, careful investigations have proved that a granular material possesses none of the characteristics of a liquid. (See Ketchum's Structural Engineers' Handbook," pp. 407-408.)

Assuming, for the moment, that a granular material may be considered a liquid, let us analyze the analogy. Suppose we measured the discharge over a shallow weir of, say, 12 ft. in length and a head of 5 to 6 in.; that is, the ratio of the length of the crest of the weir to the head is about 25 to 1. Suppose the weir is warped and no longer normal to the flow, the crest of the weir uneven and not level and the head is measured by a yardstick instead of a hook gage, at some point where there is considerable disturbance. Of what use would such measurement be? The traveling grate corresponding to the crest in the analogy may be straight enough or level enough for propelling coal, but it is never straight and level enough for measuring purposes. In the case of a liquid we are sure that the surface is level. What assurance is there that the surface of the coal is level? The gate, which is supposed to level off the coal, is usually warped by the heat and worn unevenly by the corrosive and abrasive action of the coal. It may perform its duty satisfactorily for the purpose of maintaining a "uniform" fuel bed, but it is not even enough for measuring purposes. The position of the gate, which corresponds to the position of the hook gage in the analogy, is transmitted to the recording device by means of a cable or chain, pulleys, gears, etc. The error introduced by the variation in the length of the cable due to temperature variation and stretching, the wear of the grooves of the pulleys, gear play, sag due to friction, etc., are far from being negligible. By what stretch of imagination can a stoker be converted into a meter by the simple attachment of a revolution counter? It was not intended for that purpose and possesses none of the refinements of a measuring instrument.

Mr. Evans cites as proof the fact that there are numerous installations abroad. This is hardly a proof. Numerous plants in this country are determining the daily coal consumption from chalk marks placed by the fireman upon the wall, each mark representing a certain number of shovelfuls or wheelbarrows, and the water evaporated from the number of water-softening tanks filled. Does that prove that it is good practice? Then again, quite a few devices purporting to have given satisfactory service in Europe have failed in this country, thus almost upsetting our ideas regarding the universality of the laws of physics and mechanics! It is possible, however, that European operators are more skilled and patient or less exacting than American operators.

Neither is the fact that a number of a certain device have been ordered for certain plants convincing proof. It has been my experience that the catalog references regarding the number of installations giving satisfactory service are not always the complete truth. The manufacturers of a certain piece of equipment have in their catalog that the concern I was connected with have seventeen of that particular device installed. They fail to mention the fact that they were scrapped after several months' of fussing with them. That other engineers have had similar experiences is evident from the number of devices that have fallen into disuse in boiler rooms.

I am of the opinion, based on extensive and careful observations, that the volumetric measurement of coal is rational, simple and inexpensive and for power-house purposes is superior to actual weighing. But that method will stand no more rough handling than any other method, whether it be that of the weir meter, venturi meter, or wattmeter. Suppose an ammeter had been connected carelessly, making a high resistance contact on the shunt, or the leads furnished with the instruments were shortened "for convenience." Of what reliability would the measurements be? And no one questions the correctness of the principle of the ammeter. Care in the application of a principle is no less important than the principle itself. E. OGUR.

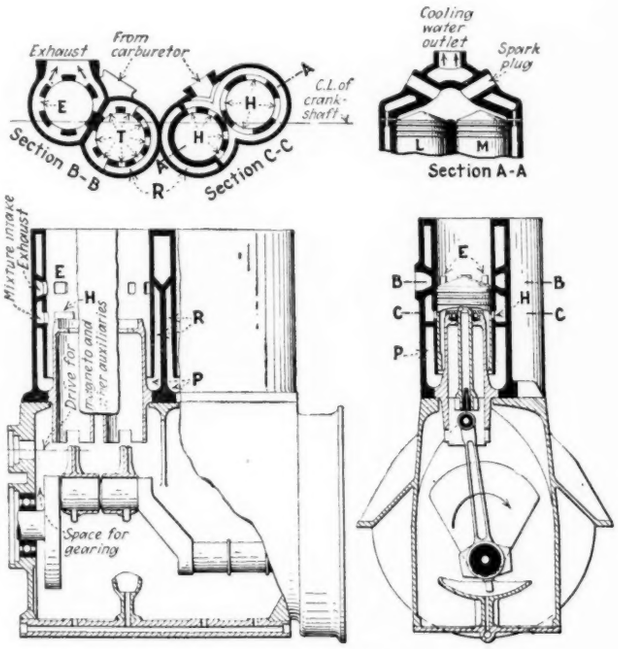
New York City.

Present Gas-Engine Designs Faulty

Referring to the editorial on the economy of high-quality internal-combustion engines which appeared in *Power*, Aug. 11, and continuing the *cri de guerre* against the wasting of fuel that occurs with our present-day gas and gasoline engines, I would add the following suggestions based upon practical tests:

With but few exceptions the design of our present-day gas and gasoline engines is woefully lacking in essential particulars, and if the matter is considered from the point of view of our extremely delicate fuel problem, the result will be an early exhaustion of our supply of petroleum.

As we must realize that it is of vital interest to conserve every kind of fuel, the manufacture and marketing of high-volumetric- but low thermal-efficiency



Twin-piston two-stroke-cycle engine

engines at an ever-increasing rate must be looked upon as being against the public welfare.

The reason that the economy of the present four-stroke-cycle engine is necessarily poor under average working conditions, is that they usually work within the range of ⅓ to ½ of their full capacity and that their output is controlled by the breaking effect of throttling the intake, thereby lowering the compression and the thermal efficiency. A logical step, therefore, to render engines such as used in motor cars more economical under average working conditions, would be to design and introduce constant-compression engines. From the points of view of simplicity and first cost I emphasize that the easiest way to obtain a suitable constant compression engine is by developing the two-stroke-cycle type of motor.

In fact, the constant-compression effect is realized to a certain extent in any ordinary two-stroke-cycle engine. This engine is more efficient under low-load conditions than any of our present throttled four-stroke-cycle engines. In the two-stroke-cycle engine, however, the quantity of charge admitted into the precompression space is controlled by a throttle; the compression within the working cylinder remains practically constant, for the volume of charge admitted into it is determined by the volume of exhaust expelled. The exhaust expelled and the charge admitted are in every case substantially the same. This fact alone would justify turning more attention toward the further development of the two-stroke-cycle engine for automotive purposes.

Observing through the exhaust ports the interior of the engine cylinder, no luminosity or incandescence can be seen when the exhaust port is uncovered. This surprising fact must be regarded as conclusive evidence that the combustion in the two-stroke-cycle engine is complete by the time the exhaust port is over-run by the piston. The relative inefficiency of the engine, in spite of the nearly complete combustion occurring in it, is due entirely to the working principle of the generally applied three-port type, in which a certain amount of live gas is blown out through the exhaust ports.

Our principal effort, therefore, must be to produce a two-stroke-cycle engine in which complete combustion is reached and provided with simple means to eliminate mixture losses through the exhaust port.

Of the different methods conceivable to get this result, I believe supercharging is the most promising one. The term covers a working principle wherein the exhaust ports are closed before those provided for the intake and in such a way that a certain amount of fresh gas mixture is introduced into the working cylinder after the exhaust period has ceased. This working principle enables one to obtain higher mean effective pressures and at the same time minimize the loss of fresh mixture through the exhaust ports.

These facts have been substantially corroborated by the results of tests with a small opposed-piston type supercharging engine shown in the illustration. Two pistons *L* and *M* working in cylinders slightly offset from the shaft center line are connected to each crank-pin. Each piston compresses the mixture in the chamber *P* entering through the ports *H*. Exhaust is at *E*. The engine gave a fuel consumption of 0.52 lb. per hp.-hr. within the load range of from full load down to one-third load. Moreover, this two-stroke-cycle engine, while simpler than is any of the present four-stroke-cycle type in general use, will inevitably be found to be much less in first cost as well as in cost of upkeep. The strains on several mechanical parts are also more even with this engine.

Manufacturers of high-speed gasoline engines owe it to the public welfare to face about and build more economical machines which are more suitable for the average working conditions than the present day "oil-eaters."

Unfortunately, the tendency goes along a mistaken way, thus making our present hopeless fuel situation still worse. In fact, the greatest number of engine builders are still vieing with one another to see who can obtain the most horsepower per unit of piston displacement and do not consider that the volumetric efficiency has nothing to do with the output per unit of fuel consumed. The efficiency of present engines falls off rapidly with decrease in load, and as the average working conditions are those of low load, their economy is necessarily poor. This rut of high volumetric but low thermal efficiency should no longer be tolerated.

From the point of view of operating economy, the orthodox four-stroke-cycle high-speed engine is a flat

failure, and while the sale of this poor-quality product to the ignorant public at an ever-increasing rate assures only big profits to manufacturers, every purchaser suffers financial losses. Through the discouraging and unwarranted opposition of manufacturers to depart from beaten paths, the improvements obtained in experimental and research work for better engines are not transferred at all into the general practice, and the startling gasoline consumption by our automobiles, representing hundreds of millions of horsepower, accentuates every day more the future inadequacy of our liquid-fuel supply. CHARLES J. TOTH.

Montevideo, Uruguay.

Power-Plant Instruments

The letter by Mr. Risley in the Sept. 8 issue mentions the importance of checking the accuracy of flow-meter integrators at frequent intervals. He is right, but why use a planimeter? Why not check the instrument itself? I think this way much more satisfactory and it is easily done.

First check both pen and integrator for zero by shutting down the instrument and equalizing the pressures in the meter body. If they do not check at zero, they must be adjusted to do so.

Next bring the pen up to exactly half scale on the chart, the integator of course traveling outward from the center of its drive disk with the travel of the pen. This may be done either by means of a water column imposed on the pressure transferring medium of the instrument, or by disconnecting the lever that actuates the pen and integrator from the bell or element of the instrument and moving the pen to the desired position by hand. Block or wedge the lever so that the pen and integrator remain exactly at the desired point. The water column is preferable, but accurate results may be obtained by the latter method.

Next release the integrator drive disk and make a mark on it with a piece of chalk at a point on its circumference. Then line this mark up with a mark on the instrument case. Read the integrator accurately and note the reading on a pad. Revolve the drive disk in its normal direction of rotation the equivalent of ten hours' run. Read the integrator again and subtract the first reading from the last and multiply the difference by the standard multiple for the instrument. The result should be accurate within 2 per cent for ten hours' run at the rate indicated by the location of the pen on the chart. If the reading is high, the integrator may be adjusted for lower reading. The adjustment is easily made on most instruments, either by means of connecting links or by micrometer screws at the point of attachment of the integrator to its arm.

If the reading is low, it is well to determine first whether it is due to slip. The most common cause of slip is a film of oil or grease on the face of the drive disk. This should be cleaned with soap and water or a cloth dipped in gasoline and, when dry, rubbed over with fine sandpaper. Note also that the drive disk runs true in its bearings and has no low spots where the driven disk does not make proper contact. Also note that the springs, if any, that force the driven disk into contact with the drive disk, or vice versa, are in good condition. If they are not, they should be removed or adjusted. Having cleaned the disk and observed the other points of probable error, repeat the check as before described.

If the difference is still great enough to warrant, correction may now be made for low reading in the same manner as for high, only, of course, adjusting in the opposite direction. It is surprising how easy this is to do, once one is familiar with the instrument. It also has the advantage of affording an opportunity for a general inspection which the instrument should have from time to time.

It should also be borne in mind that inaccurate clocks mean inaccurate records. Both the meter clocks and the clock by which the charts are changed and integrators read should be reasonably accurate. A twenty-four hour record should be for exactly twenty-four hours; if it is for more or less and is figured for exactly twenty-four hours the error in the record will be in proportion to the error in time. This may easily be 5 per cent in a group of meters. L. A. PIERSON.

Devon, Conn.

Producer-Gas Engines for Desert Regions

In *Power*, May 5, L. D. Anderson, of Utah, wrote that for a long time there had been no mention of gas engines as prime movers and asked for information. J. F. Edgell, of England, replied in the issue for Sept. 22 and said that an engine would work as well with producer gas as with blast-furnace gas, and gave a few notes on pressures, coal consumption and operation.

During the threatened shortage of oil and gasoline in 1920, I suggested in several publications that the use of producer-gas power plants be further investigated. Those who discussed the problem were not enthusiastic over the use of producer-gas power plants.

Prior to the advent of the oil engine, which practically stopped the development of producer-gas power units, there had been considerable investigation concerning their use. In 1913 the producer-gas engine was at the height of its popularity. At that time there were 722 producer plants in America, 610 burning anthracite, 77 bituminous coal, 32 lignite, 1 wood, and 2 oil, mostly in the Northeast and North-Central States. It appears that this type of plant needed special fuels in order to reduce the labor charge. In effect, it failed to utilize low-grade fuels and waste products.

In 1921 there was only 18,500 hp. of producer-gas engines in central power stations of the United States, which was under 10 per cent of the total of internal-combustion engines in those stations. In England and Europe many times this output of power is generated by producer plants, and judging by the plants I saw in Australia and the extension of their use in that country, I believe the American output would be nearly equaled in Australia. Several well-known British firms have specialized in suction-gas producers and engines for half a century and have splendid records in designing such plants to make producer gas from all manner of combustible byproducts.

In Australia, producer-gas power plants are largely used in desert and out-back districts, yet many are operated in cities. They burn bituminous coal, charcoal, coal, coke, lignite and wood, the last mentioned up to 6-ft. lengths. The results are generally satisfactory and of low cost.

There is nothing complicated about the suction-gas power plant, and under certain conditions, as probably exist in Utah, such equipment should be found of advantage. M. W. VON BERNEWITZ.

Pittsburgh, Pa.

New and Improved Equipment

Stoker for Small-Sized Anthracite

The illustrations show assembly and partial details of a traveling-grate stoker known as the "Turbulator," recently developed by Albin A. Norrman and Alfred E. M. Shafer, Tamaqua, Pa., for burning the smaller sizes of anthracite such as No. 4 buckwheat and culm.

The stoker consists essentially of a series of hollow grate sections connected together to form a continuous surface, the whole being inclined at an angle toward the front of the furnace.

A series of chambers *A* conduct the air for combustion to each section of the grate. The chambers are connected to a common air duct placed along each side of the stokers, as indicated by the dotted lines in Fig. 1. The amount of air to each section is controlled by a disk valve *B*. The grate sections *C* are cast members channel-shaped in form, having openings at each end, on the bottom. The openings are on opposite sides of the longitudinal axis, the purpose of this being to give a continued supply of air to the grate while passing over the web between the ports in the wearing plate *D* which is incorporated between the bottom of the grate sections and the air chamber.

The attached grate sections are carried on two sprockets at the front and rear, the sprockets at the front being the driving members. The rear sprockets also carry a sheet-iron cylindrical drum somewhat smaller in diameter than the sprockets to provide an air seal and prevent ashes from dropping through. The shafts supporting the sprockets are carried in roller bearings.

Fig. 1 shows a typical installation of the stoker under an inclined water-tube boiler, and Fig. 2 is a detail of the grate sections and air-control arrangement.

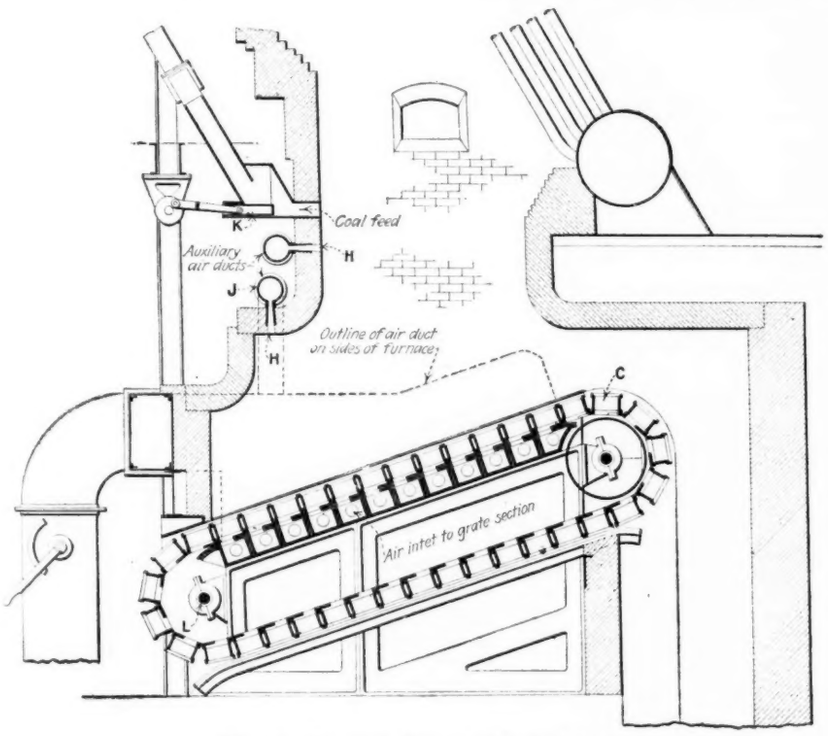


Fig. 1—Cross-section of "Turbulator"

Auxiliary air supply to the combustion chamber above the fuel bed is afforded by the slotted openings **E** through the walls connecting with the air duct *F*, and the amount of air passed through the openings is controlled by valves *G* which are opened and closed by means of a wheel and chain.

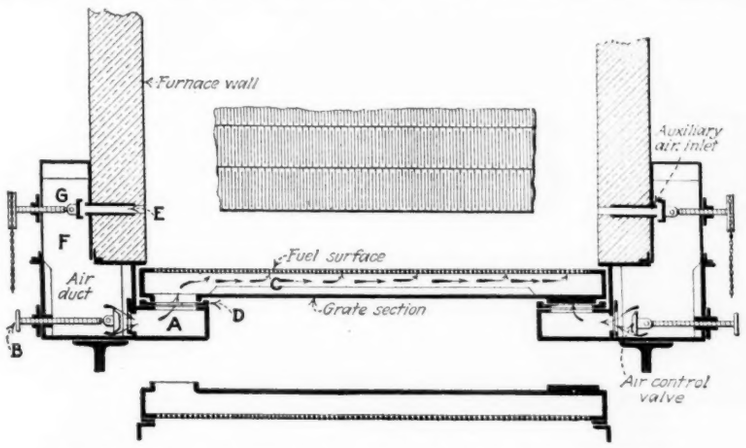


Fig. 2—Detail of grate section and air-control arrangement

Another source of auxiliary air supply to assist in burning the volatile matter is through the openings *H*, Fig. 1. The air is supplied to the pipes *J* through a connection from the top of the wind-box at each side of the stoker as indicated.

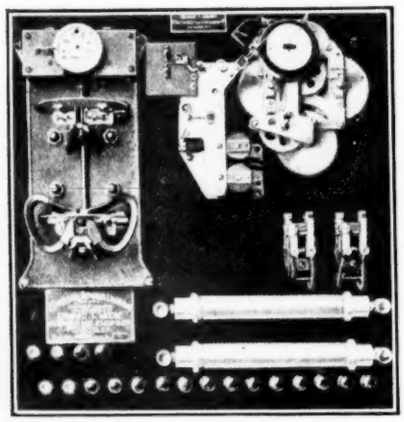
The fuel is fed to the furnace from a small hopper by means of plungers connected to short-stroke cranks, which are in turn driven through the speed-reduction gear which drives the main shaft *L*. By feeding the coal to the furnace at this point, it is caused to pass through the hot gases, which allows the fine particles to burn in suspension and the larger ones to become ignited, before reaching the grate.

Some of the advantages claimed for this stoker are the ability to burn large quantities of coal per square foot of grate surface per hour, due to the independent method of feeding the fuel and controlling the air supply to the grate; exceptional capacity, due to the fuel being ignited before reaching the grate; and rapid pick up of rating, due to large quantities of fuel on the grate.

Limiting Maximum Demand of Power Loads

A demand or readiness-to-serve charge has in general become a part of the charge made by power companies for electric service. With loads subjected to high sustained peaks the demand charge is a large proportion of the total power bill. Anything that can be done to reduce the peak loads will

tend to reduce the readiness-to-serve charge and therefore reduce the total cost of the power used. One way of doing this to to take some of the load off, during the peak periods, that can be removed without interfering with the manufacturing production. There is nearly always some load in all large manufacturing plants that can be taken off temporarily without holding up production. Some of these loads are



Maximum-demand limitator

motor-driven pumps, air or ammonia compressors, electric-furnace loads and motor-driven grinders in paper mills.

To take care of such conditions the Edmoore Demand Limitator, shown in the figure, was developed by Edward T. Moore, consulting engineer, Syracuse, N. Y., and recently placed on the market by the Pittsburgh Electric Furnace Corp., Pittsburgh, Pa. This equipment has a wattmeter element which is connected to the current and potential transformers at the main metering point of the power line to the consumer's premises. Also, an electromagnetic mechanism that is actuated periodically, depending upon the period of the demand, by a set of contacts mounted on a standard watt-hour meter. The limitator, when connected to such loads as can be varied or taken off the system temporarily, will operate to control these loads so as to keep the integrated demand within the limits determined upon. High peak loads of short duration may be carried on the system without the limitator functioning, so long as the integrated value does not exceed the predetermined limit.

For example, in the case of an air compressor, in addition to the limitator equipment, a solenoid air valve is placed in the air intake line to the compressors. When the maximum demand on the system reaches the predetermined setting of the limitator, the solenoid-actuated valve is operated, the air intake to the compressor cut off, which reduces the mechanical load on the motor, thereby reducing the electrical load on the system at the time of maximum demand without shutting down the motor. After the demand period has expired, the solenoid-operated valve will be opened, the compressor will resume the supply of air, and the electrical load on the motor is restored.

In cases where the mechanical load cannot be readily reduced, the motor may be shut down when the demand reaches the predetermined setting. After the expiration of the demand period the motor may be started automatically if such means are provided, or a signal may be given when the motor may be started up by hand.

Tagliabue Electrically Controlled Viscosimeter

The C. J. Tagliabue Manufacturing Co., Brooklyn, N. Y., has recently added to its line of instruments the electrically heated, stirred and controlled Saybolt viscosimeter shown in the illustration.

The instrument consists essentially of a tank or bath fitted with four fixed-volume oil cylinders, electric heater, motor-driven stirrer and thermostat, and a panel on which are mounted the thermostatic contacts, relays, automatic switches and rheostat.

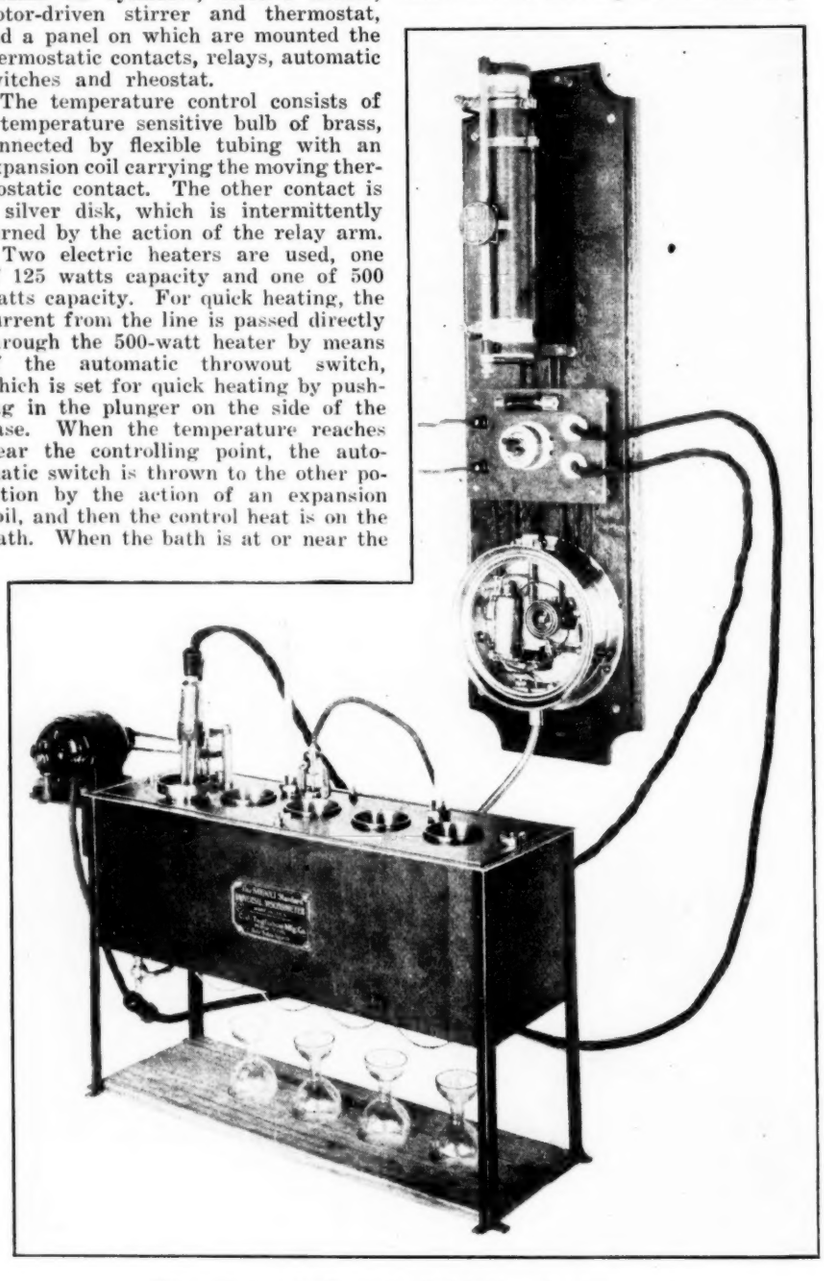
The temperature control consists of a temperature sensitive bulb of brass, connected by flexible tubing with an expansion coil carrying the moving thermostatic contact. The other contact is a silver disk, which is intermittently turned by the action of the relay arm.

Two electric heaters are used, one of 125 watts capacity and one of 500 watts capacity. For quick heating, the current from the line is passed directly through the 500-watt heater by means of the automatic throwout switch, which is set for quick heating by pushing in the plunger on the side of the case. When the temperature reaches near the controlling point, the automatic switch is thrown to the other position by the action of an expansion coil, and then the control heat is on the bath. When the bath is at or near the controlling temperature, both heaters are used—one with sufficient current supplied continually to keep the temperature near but not above the controlling point, the other being on and off, depending on the position of the thermostatic contact. The temperature setting can be changed by means of a thumbscrew at the top of the case.

The sliding contact on the rheostat, shown at the top of the panel, is used to vary the amount of current on the uncontrolled heater. It may also be adjusted occasionally to take care of extreme conditions of atmospheric temperature.

Uniform temperature within the bath is obtained by a motor-driven stirring device, and either water or oil can be used as the transferring medium.

The bath is designed to control at one temperature only, since the greatest demand is for a bath to be used at either 100 or 210 deg. F. continuously.



View of electrically controlled bath and relay panel

Thermodynamic and Practical Features of Pulverized-Coal Firing*

By Dr. Ing. Rosin

THE burning of a combustible may be a surface or a volume reaction. For solid and liquid combustibles under normal pressure conditions, it is always a surface reaction and takes a quite definite time, which depends upon the area of the active surface.

The burning of gases and vapors may be a surface as well as a volume reaction. In the former the bulk of the gas, or vapor, comes in contact with the air only on the surface dividing the bulks, as, for instance, in bunsen burners. But it can become a volume reaction when the gas and air were mixed beforehand and brought up to a sufficient pressure and temperature. In the second case the reaction starts in every point of the mixture, the velocity of reaction becomes indefinite and the combustion is an explosion.

Conditions Governing Surface Burning and Explosion

With a uniform distribution of coal dust in air, the distance between adjacent particles must be 18 times the size of the corresponding mesh. For instance, for particles fitting a 4,900 sieve (32,200 mesh per sq.in.) the theoretical distance is 0.07 in. The ratio of volumes occupied by air and coal is 7,156; thus the coal takes only 0.014 per cent of the space as the distance between the particles are measurable, the combustion must be a surface reaction proceeding in a measureable time.

It follows, therefore, that with this ratio of volumes, an explosion of coal dust is impossible. But when the ratio of volumes changes to such an extent that it corresponds to the ratio of a gas and air volume in an explosive mixture, then an explosion of coal dust may occur. One volume of methane explodes with 19 volumes of air. For an explosion of coal dust the combustion air must be compressed to the same ratio. With adiabatic compression the pressure required is

$$p = \left(\frac{7156}{19}\right)^{1.40}$$

$$= 5{,}000\ atm. = 74{,}000\ lb.\ per\ sq.in.$$

Such pressures are produced by explosions themselves, and even greater pressures are found in the explosion waves. An explosion of coal dust in air is possible when the dust is uniformly spread and an initial explosion occurs producing in waves the needed compression, but maintenance of the latter is possible only with a volume reaction. Therefore, the conditions necessary for an explosion are:

1. Uniform and suspension of fine dust in the air.
2. An explosion wave with pressure of the required order set by an initial explosion.

We thus see the impossibility of spontaneous explosion of gas-freed coal dust, or when the volatile matter is already burned out. The fact that explosions are unkown with coals having meager dust confirms this viewpoint.

The ignition temperature[1] of the solid part is lower than that of the volatile matter, but, on the other side, ignition of coal with low gas content is much more difficult and requires higher temperatures than those for coals with a higher percentage of volatile matter. Fortunately, this has no practical importance because the furnace temperature is well above the ignition point of the most difficult combustible. Nevertheless, it is interesting because of its probable influence on the possibility of an explosion during milling operations.

THE author shows the impossibility of spontaneous explosion of gas-freed coal dust, discusses the effect of fine milling with high-ash coals and explains the importance of correct flame length in relation to furnace deterioration.

In pulverized-coal firing one must in addition take into account the velocity of feed and the degree of turbulence in the furnace.

Of all factors affecting the ignition temperature the conditions for heat absorption and the heat of reaction are the most important. The gases are diathermic and, being transparent to radiation, the temperature is raised by close contact with warmer bodies as well as by convection and compression of the heat of reaction. For quick heating the area of contact surface is, therefore, of paramount importance. The radiant heat of an ignition source which has a small area (an electric spark, for instance) passes freely through the gas and most of it is absorbed by the colder solid bodies around. Unless this heat is quickly transferred to the gas by convection from solid bodies, it is lost to the process of heating the gaseous system. Thus if it is desired to maintain the action of an igniting source, one must help the reaction by a corresponding increase of temperature in the surrounding gas. This is possible when the ignition source is surrounded by warmer solid bodies or by ignition sources of greater surface. Such is the catalytic effect of the walls, without which the ignition temperature is higher.

If solid particles of high absorptive power are suspended in the gas, they take in the radiant heat from ignition, are heated and begin to transfer the heat to the surrounding gas by convection. Such suspended particles act for the gas as a heat-transferring medium. In this action the particles receive the heat by absorbing heat rays and transfer the heat by convection, multiplying thus the effect of a single small ignition source. Naturally, the amount of this heat-transferring dust must not be great enough to reduce (by its own heating) to an insignificant degree the total increase of temperature and create too much heat dispersion.

Methane in which a little coal dust is admixed is known to ignite much easier than in a dustless state. Also explosions of methane in mines are hindered by the stone dust. Explosions of coal dust rich in ash are impossible.

Solid Particles First To Ignite

When heating of suspended coal dust is started by an ignition source, then at a certain moment the whole mass of dust becomes ignited, the solid part of it first, followed by the volatile matter. But when the burning is once started, it can maintain itself by a volume reaction of the gases much better than by ignition process of solid particles, because the latter is a surface reaction that requires much greater time. Every combustion process to be self-sustaining must develop such heat that radiation and useful work could not lower the temperature below the ignition point. The burning coal dust has such a great radiating surface that it is pretty near to being extinguished were it not for the volume reaction of surrounding gas which comes to help with its concentration of heat energy. The coal dust blown into a heated furnace distills right away, and a suspension of gas-free dust in a combustible gaseous mixture results. Owing to their greater absorption power the solid particles of coal are ignited first, but they burn slowly. Meantime the volatile matter heated up by solid particles is ignited later, but in the volume reaction following it is burned much more quickly.

Starting a pulverized-coal furnace, when it is not quite hot, we see first the sparks of burning fixed carbon in a dark mass of unburned gas, then the gas ignites in a series of puffs, and when the walls of the furnace are hot

*Abstract of translation by N. C. Artsayooloff from *Braunkohle*, June 13, 1925.

[1]The temperature to which a point in a system must be heated to start the flash is called ignition temperature. It must not be confused with the temperature around the point where the reaction in the gas began. It would be like taking a vessel's wall temperature at a point where the boiling started.

enough, the ignition of fixed carbon and volatile matter takes place in such rapid succession that they cannot be observed separately.

Coal-Dust Explosions in Mills

With these considerations the question of coal-dust explosions in mills seems to be closed. Even if we overheat the mill and set an initial explosion, still there is the great mass of coal dust which will act as a heat-dispersion medium and ignition of the whole mass is thus impossible.

Combustion must develop an amount of heat at a rate sufficient to make up the outlet, otherwise the system will cool down and combustion cease. A high ash content will decrease the active surface and increase the combustion time. Combustion temperature goes down, and in certain circumstances of ignition the burning cannot be maintained. This fact is, of course, well known with coals of high ash content, especially when the ash of low melting point binds the combustible into a sticky mass.

With fine milling the disposition of ash in a particle of coal becomes irregular, and the dust will contain particles of purer coal and neutral particles of ash. The effect of finer milling is more noticeable in coals richer in ash, because in this case larger independent ash particles may be liberated. By sufficient milling coal rich in ash may be burned as quickly as purer coals. Experiment has shown that even 50 per cent ash coal. may be brought up by milling to a state where ash influence on combustion time is negligible.

The complete disposal of ash in the furnace is impossible, but with a right area of flues and gas velocities one can draw the flying particles of ash, which did not come to rest in the furnace, through the working part of the installation. The finer the milling and the stronger the draft, the greater the amount of ash of the flying kind.

Ash Accumulation Permissible in Ignition Chamber

Where a special disposal of ash is required, one can make a difference between the combustion chamber (furnace) and the ignition chamber. The latter has to provide the ignition temperature only for a short time while the working chamber must maintain it all the time. Thus in an ignition chamber one can allow accumulation of ash, which is not permissible in the working chamber[2]. This system of firing is very rare, because it is seldom that the matter which is worked upon in the furnace does not allow deposits of ash; mostly, it is the consideration of the extremely strong insulating properties of flying ash which forces the adoption of a separate combustion chamber.

The furnace construction thus becomes the main question of the whole problem of pulverized-coal firing. A great many of the earlier installations were destroyed after a short working time. An attempt was made to explain the furnace deterioration by a chemical and abrasive action between the molten slag and the refractory material at high temperature, the latter resulting from low excess air. But this explanation requires an explanation of abrasive action, which is again a deterioration.

A research made by the author has shown that this abrasive action occurs only when the burning flame comes into close contact with furnace walls, when the stream of burning coal dust strikes the walls or grazes them lengthwise. It happens also when there is an excess pressure in the furnace which presses the flame in the cracks and seams. If a suction is maintained in the furnace (of such size that the flame burns without touching the walls) the abrasive action does not occur even at the highest temperatures. So if a furnace draws air through seams and little cracks, it will make itself a natural protection. One must have care that molten slag does not stay in.

Requirements To Be Met by Furnace

Thus a pulverized coal furnace must fulfill the following five requirements:

1. The coal dust during combustion must be in suspension and motion.
2. The coal dust must burn out completely in the furnace (combustion chamber).
3. The flame must come nowhere in contact with brickwork.
4. A steady suction draft in the furnace must be maintained.
5. The temperature of the inner surface of the walls must not rise above the point of softening for the refractory.

The requirements 1, 2 and 3, taken together, mean that coal dust of certain combustion time must have a free path to burn completely. Length and direction of this path must correspond to the combustion time of the biggest particles of coal dust.

If dust is of a size fitting the 2,500 sieve, which corresponds to combustion time between 1.5 and 2.0 sec., the free way for flame must be about 15 ft. for an entrance velocity of 10 ft. per sec. If the dust is blown through a single burner with a velocity of 98 ft. per sec. and the mean velocity of flame is 33 ft. per sec., the flame will be about 49 ft. long, which the furnace, of course, cannot give, and in this case the combustion will go into the working chamber and all the drawbacks of deposited soot will be experienced, the flame may deposit some of the unburned coal dust in the furnace, and, worst of all, acting on the brickwork as a blowtorch, it will not give a chance to any refractory material.

One can combine the preheating of air and cooling of furnace walls in three ways:

1. The air may be admitted between the double walls and drawn into the furnace by the negative pressure in the latter.
2. The air may be drawn from the space between the walls by a fan and discharged through the burners or right into the furnace.
3. The air may be blown through the space between the walls by a blower and discharged through burners or right into the furnace.

The first way is possible when the furnace is always below maximum load and a steady draft is maintained. Much depends on careful manipulation of furnace doors and air registers. If an overload happens, the hot gas is pressed into space between the walls, making a hot insulation instead of cooling. Fast deterioration of the furnace generally follows.

The second way of preheating air is not practical, because with lowered air pressure between the walls much hot combustion gas will be sucked in through unavoidable cracks and general air permeability of hot brickwork. In order to maintain the cooling of walls, the pressure in the furnace must be lowered, which involves a reduction in the furnace load, otherwise the suction of hot gas into space between the walls will create a hot gas insulation followed by a rapid deterioration.

The third way of air circulation is, therefore, the best. One must provide a uniform flow of air between the walls and spread cooling effect evenly on all outer surfaces of the furnace. Of course, a thermal gain is obtained with preheating, but deducting the power necessary for the blower expressed in thermal units, it will be found that the gain is insignificant compared with the performance of a simple furnace with natural cooling.

Where the working and combustion chambers are in one, the heat transfer by radiation and contact is taking place simultaneously. Where there are separate combustion and working chambers, the latter receives the heat by radiation first and then the hot gas comes from the combustion chamber after doing its share of destructive work. So we get a rule:

The radiation is independent of the distance; therefore the direct lengthwise separation of combustion and working chambers does not matter.

Often pulverized-coal furnaces are compared with regenerative furnaces in which the initial temperatures are almost as high as with pulverized-coal fire, but nobody dreams to reduce the temperature by admission of excess air, even though by strong preheating and good combustion one strives to increase the temperature. In spite of this such furnaces last longer than pulverized-coal furnaces. An attempt was made to explain this fact by a combined action on brickwork of slag and high temperature, but by maintaining proper pressure in the furnace one can stop the slag from coming in contact with the brickwork. On the other hand, one does not put in regenerative furnaces a refractory that would not stand high initial temperatures any prolonged time.

The cause of this different behavior may be found in the actual temperature of the walls. In gas-fired regenerative furnaces, in spite of high initial temperature, the temperature of matter worked upon and of the walls is much lower; lower, in fact, than the practical limit that the refractory stands easily. In many pulverized-coal furnaces with the same initial temperatures, the mean temperatures pass the stability limit for the brickwork.

[2] The firing with ignition chambers was installed at "Zeche Friederich Ernestine" mines (Hold. Gluckauf 1921 H 50, s 1175) in tubular furnaces. It was found that only 15 per cent of ash contained in pulverized coal comes to rest in ignition chambers.

Gas Welding of Power Plant Piping in Shop and Field*

By A. W. MOULDER
Chief Engineer, Heating, Power and Industrial Piping Division, Grinnell Company, Inc.

FROM a practical viewpoint the possibilities of welding in the field of power-plant piping are as broad as the field itself. In the opinion of the writer only one single thing has has intervened to keep all-welded pipe lines in power-plant work from being the rule rather than the exception as at present. This is the importance of the human factor. In welding work the individual workman has a responsibility put upon him that is greater by far than in any other similar type of work. Quality of workmanship becomes the measure of strength and reliability, and because workmanship cannot be specified like weight of pipe or strength of fitting, welding has fallen far short of the wider uses its unquestioned advantages should have secured for it.

Butt Weld Sufficient

Our experience, dating back to 1910, is that the plain butt weld, properly made, is as strong as, or stronger than, the base material itself. That is more than can be said for a great many other methods of joining pipe. Obviously, strength equal to the base metal is all that can be desired in any joint.

Welding of power-plant piping has many advantages, most of which are relatively applicable whether the system is only partly welded, as for example the headers, or whether the system is welded as nearly as possible in its entirety. Up to date the great bulk of power-plant welding has been fabricated in the shops of regular manufacturers engaged in that work. Some of these same concerns have, during recent years, successfully carried welding right into the power plant itself by doing pipe-line welding on the job. This latter development has grown quite rapidly, in some few cases having been carried to the extent of eliminating, on some lines, practically all fittings and providing flanges only adjacent to valves and apparatus.

To illustrate the relative first cost of two simple headers which might be incorporated in the design of any small power plant, I am showing Fig. 1, which in the one case illustrates a welded 10-in. high-pressure steam header for a battery of several boilers and with outlets for several connections to turbines, etc. With the dimensions and materials shown on the sketch the cost of this welded header would be $332. The other illustration in Fig. 1 is that of a header for the same purpose but made up of the same weight steel pipe with lap-joint[1] flanges and extra-heavy cast-steel fittings. The cost in this case is $1,034.

Fig. 2 shows a large low-pressure exhaust-steam header, in the one case made up of welded and in the other case made up with lap-joint piping and cast-iron flanged fittings. The welded header would cost $269. As shown with flanges and flanged fittings, the cost would be $478.

These startling differences in price probably explain why there has been a more rapid development of welding in headers and allied work than in other pipe runs in power-plant work, since the saving is largely proportional to the number of flanged fittings and joints. Even when fewer joints are involved, the saving is still substantial, particularly in view of other advantages to be discussed later.

In the case of Fig. 1 there is also a saving in weight of 2,980 lb. and in the case of Fig. 2 a saving of 3,530 lb. both in favor of the welded headers. This naturally means a relative saving in labor of handling and installation, so that the entire saving is not shown simply in difference in price.

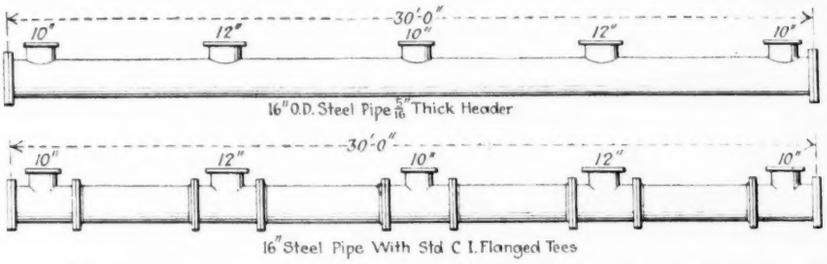


Fig. 2—Comparison of 16-in. welded exhaust header with one having cast-iron flanged fittings

These savings in first cost apply to work that is almost invariably done in the shop. The question naturally arises as to whether such savings can be made in field work where the facilities for welding are not so good. The answer to this question is best given by the following figures covering an actual job we installed for a large western manufacturer. This job was the installation of 875 ft. of 16-in. O.D. steel pipe installed in a concrete tunnel.

Cost of Field Job

The following shows actual cost as installed with 43 butt-weld joints and 20 standard rolled-steel flanges, used adjacent to valves and expansion joints:

16-in. O.D. steel pipe, ¼ in. thick, 875 ft.	$2,062.90
Mill shipment freight	153.55
16-in. standard-weight rolled-steel flanges, 20	386.16
16-in. red-rubber gaskets, 20	30.00
1 x 4 bolts and hex. nuts, 320	53.13
Drums acetylene gas, 30	193.20
Drums oxygen gas, 45	163.25
Welding steel, 100 lb.	16.50
Total cost	$3,058.69

The following shows the actual cost of materials if lap-joint piping had been furnished from one of our fabricating plants.

16-in. O.D. steel pipe, ¼ in. thick, 875 ft.	$2,394.44
Fabricating-plant cost	None
Freight from fabricating plant	233.10
16-in. lap joints with standard C.I. flanges, 88	1,306.80
16-in. red-rubber gaskets, 63	94.50
1 x 4½ bolts and hex. nuts, 1,008	175.02
Total cost	$4,203.86

The foregoing figures show that in this instance the material fabricated for lap joints and delivered to the job would have cost approximately 37 per cent more than the materials for the job as installed with welded joints.

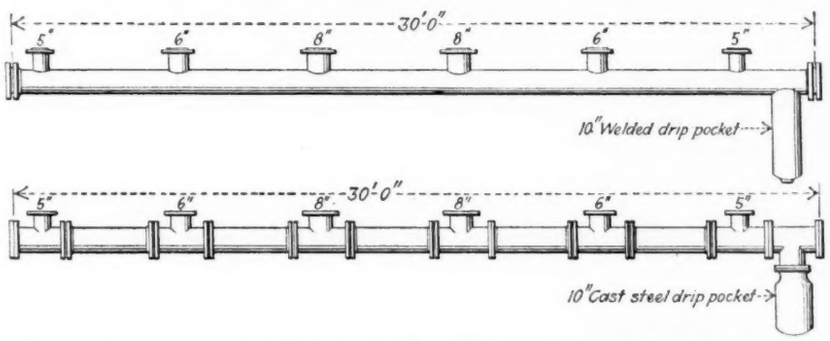


Fig. 1—Comparison of 10-in. pipe header having welded nozzles and lap-joint flanges with line made with cast-steel tees

*Abstract of paper presented at Fall Meeting, American Welding Society, Boston, October, 1925.

[1]The term "lap joint" as used throughout by the author designates the so-called Van Stone joint.

There is also a considerable saving in first cost due to the heavy expense of insulating flanges. With welded piping many flanges are eliminated and a more economical job of pipe covering is obvious. In fact the great difficulty of adequately insulating large flanges often results in their being left uncovered with consequent serious heat losses. In some cases flanges are also left uncovered to facilitate repairs and replacement of gaskets.

The extent of the savings by having a perfectly insulated line have been demonstrated by the engineers of the Superheater Co., the record of whose tests, presented before the A.S.M.E., showed that a pipe with bare flanges, but insulated along the body of the pipe lost half as much heat as did a totally bare pipe.

Another economic factor that is particularly apparent in large lines for low-pressure work is the saving in weight of the pipe itself. Where pressure factors are not involved, engineers by specifying welding would of course show a considerable saving in the class of pipe used. These various factors of fabrication, construction and saving in materials combine to make welding under a great many conditions a very much lower first-cost proposition than other types of joints. More important still, these savings are made with an increase of efficiency if the welds specified are properly made.

Improves Contractor's Service

Perhaps of even greater importance than the money saving, where all or part of the welding is done on the job, is the improved service which such procedure allows the contractor to give. If all piping must be fabricated to exact length, as is the case unless welding on the job is done, it means that measurements for a portion of the piping at least cannot be taken unless the apparatus, such as boilers, turbines and auxiliaries, is in place and lined up. It is then necessary to order these materials, get them fabricated and ship them, often at an extra added expense and with consequent actual delay in time of starting of the power plant.

For the high-pressure and high-temperature lines where cast steel fittings are usually required, another element that has an important bearing on service enters into the proposition.

As you know, the manufacture of steel fittings and cast-steel headers is a somewhat speculative undertaking. The several fittings and headers of this kind required for a given job may be ordered weeks and sometimes months in advance. When finally cast, there is always present the possibility that one or more castings will be found defective and will tie up the entire job. Defects in the casting may not become apparent until machining operations are well along and sometimes such defects do not show up until after the material is completely installed and tested. This feature often results in the discovering of defective material at the last moment with delays caused by reorders and remanufacture running to weeks and months.

Even where cast-steel fittings are not required, this same element of delay is often present. An example of this is large condenser and exhaust steam piping where the cast-iron fittings necessary almost invariably include some "specials."

Welded Anchors at Ford Plant

Where welding is being employed in lines and headers, it will at once occur to designing engineers and construction forces that the same process can be utilized to simplify greatly the often vexatious problems of anchors and supports. For instance, welded shapes can be made as required of flat or structural steel. Fig. 3 shows a typical anchor on the large main of the Ford Motor Company in Chicago. This is part of an extensive hot-water heating system in that great plant where all mains from 7-in. to 16-in., totaling 5,000 ft., were butt-welded on the job. The welded anchor was constructed with a piece of angle iron welded to the top of the pipe.

Another point very much in favor of welded piping for power plants is of course the fact of a much lower maintenance cost due to leaky joints.

All of the foregoing advantages are so real, so obvious and so important that the problem of removing the one single factor that limits their wide extension to the whole field of power-plant piping becomes one of transcending importance. As previously pointed out, the single restricting factor is the development and perfecting of some method to assure that absolute dependability of workmanship which is the crux of the situation.

As before indicated, our own experience has thoroughly satisfied us as to the strength and dependability of plain butt welds on pipe runs and the very simplest type of nozzle weld. As a result, we have standardized on preparing materials as shown in sketches *A* and *B*, Fig. 4.

An experience of nearly 15 years in welding has convinced us that careful preparation of materials in this manner insures a weld as strong as the base material itself, provided, of course, other factors are just as carefully observed.

Simple Method of Attaching Flanges

Sketch *C* shows the method of attaching a flange which we believe is the most satisfactory for this class of work regardless of pressure. Where a flange is necessary at all, it usually comes up against a piece of apparatus or valve and the lap-joint flange allows a flexibility for connecting which is very desirable. These lap-joint pieces with their flanges can always be furnished in short lengths, with the end already machine chamfered to be welded into the line at any point. In our judgment there is little excuse for a welded flange, as it has no advantages over the lap joint flange since the latter can be made fully as strong as the pipe itself.

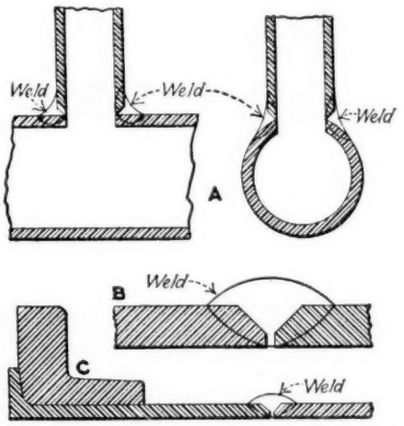


Fig. 4—Standardized preparation of piping for welding

A — Outlet on pipe. *B* — Butt joint on pipe. *C*—Attaching short lap-joint (Van Stone) section by butt weld.

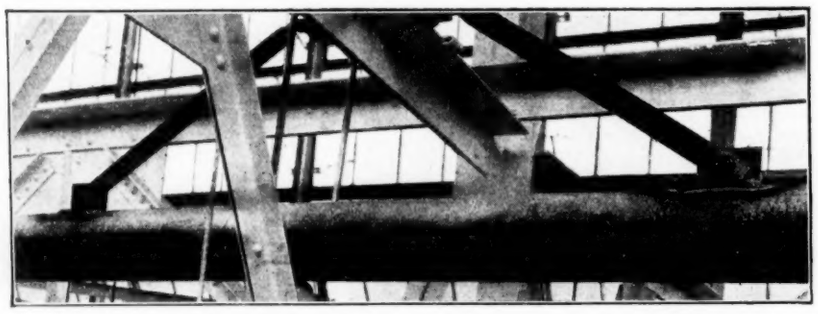
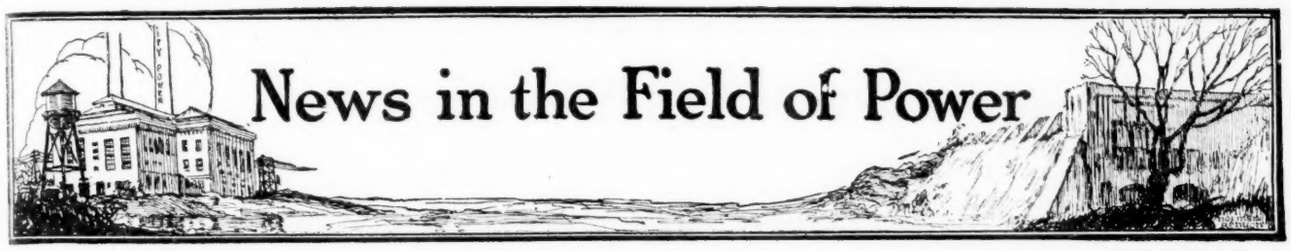


Fig. 3—Welded anchor for large main in Ford plant in Chicago

Must Have Trained Welders and Careful Supervision

In spite of an established method, careful training in that method and the development of a corps of men who do nothing but welding, our experience indicates that some check on welders must be constantly employed to keep them up to the standard. Our practice in this important matter is to take test pieces in the form of strips cut from the actual work at odd and unexpected times.

It is now quite generally recognized that the most reliable test for welded work is what is called the "pressure and impact test." Each section of piping as it is completed should be tested with a hydrostatic pressure at least three times the working pressure in pounds per square inch. While holding this pressure the piping on either side of the weld for a distance of not less than three inches should be thoroughly hammered. This should be done around the entire circumference of the weld.



Oil and Gas Power Week To Be in April

The Oil and Gas Power National Conference will be held from April 19 to 24, according to recent announcement of the committee. The purpose of this conference, which is participated in by a large number of national technical and industrial societies and associations, is to stimulate meetings where discussions will take place which will focus the attention of the physicists, chemists, engineers, operating men and industrialists on the recent progress of and the immediate possibilities in the utilization of oil and gas for power purposes.

Giant Power Report To Be Interpreted

The Administrative Board of the American Engineering Council, meeting at Columbus, Ohio, Oct. 29 and 30, authorized the appointment of a committee to review and analyze the Giant Power Report issued by Governor Pinchot of Pennsylvania. The reviewing committee is to be chosen by the executive committee of the Council, to which it is to report at the earliest practicable moment.

The board's action taken unanimously, followed representations that the Giant Power Report contains economic fallacies likely to mislead the public. The aim of the analysis is to provide a popular interpretation of the report from an engineering viewpoint.

Plans contemplating a nationwide study of public utilities were set in motion by the board, which voted to appoint a committee to determine a definite scheme of investigation and report to the Council at its annual meeting in Washington early in January.

The committee, which will submit a program for the consideration of the Council, consists of Dean Dexter S. Kimball, Cornell University, and Fred J. Miller, both past-presidents of the A.S.M.E.; A. W. Berresford, of Niagara Falls, N. Y., American Institute of Electrical Engineers; and Lawrence W. Wallace, of Washington, executive secretary of the American Engineering Council.

Questions confronting the engineers, should the Council decide to undertake the study, involve where federal regulation should end and municipal regulation begin; what should be the policy with reference to regulation of superpower systems; whether methods of regulation should be written into state constitutions; theories of valuation; theories of rate making and the standards of service required by federal and state commissions.

The cost of the survey was estimated at from $25,000 to $35,000. Action of the Administrative Board followed a recommendation by its Executive Committee that the American Engineering Council undertake a survey of "the regulation of public utilities."

Scott Turner Chosen as New Head of Bureau of Mines

Scott Turner, of Lansing, Mich., has been selected for the directorship of the Bureau of Mines. As Congress is not in session he has been given a recess appointment by President Coolidge. He is expected to assume his new duties Dec. 1.

New England Conference Will Discuss Power Subjects

The New England Conference called at the suggestion of state governors which is to meet at Worcester, Mass., on Nov. 12 and 13, to discuss the larger cpmmercial and industrial interests of the Northeast, are to hear Secretary Hoover speak on a topic of economic importance not yet announced, as well as other leaders of national thought. On the afternoon of the first day, at the Hotel Bancroft, a power session is planned under the chairmanship of Samuel Ferguson, president of the Hartford Electric Light Co. President Frank A. Belden, of the New England Division, N.E.L.A., will attend, and among its speakers will be O. D. Young, chairman of the G.E. Co. Board, and Dexter Cooper, engineer of the proposed development on Passamaquoddy Bay, Maine.

Upper Mississippi River Being Studied

Under an authorization in the last River and Harbor Act the Corps of Engineers is studying the problems of improving the upper Mississippi. General Harry Taylor, the Chief of Engineers, after a personal study made on the ground, says a depth of six feet below the mouth of the Wisconsin River can be obtained without difficulty as constrictive works can be constructed with a small amount of bank protection. From the mouth of the Wisconsin River to St. Paul a depth of six feet could be obtained by similar construction, but General Taylor regards it as inadvisable as it would narrow the channel to such an extent as to introduce navigation difficulties. He inclines to the use of locks and dams.

Whether low movable dams or high dams, permitting of power development, should be built can be determined only after accurate figures are available as to the flowage damages that would have to be paid.

Three Flywheel Explosions Reported

A large flywheel at the Cleveland works of the American Steel & Wire Co. let go on Oct. 26, tearing its way through a brick wall and dropping one piece, weighing nearly two tons, on top of another plant some three hundred yards distant. Officials of the company refused to admit a representative of *Power* or to give any explanation as to the cause of the accident.

On the day previous, a still more disastrous explosion occurred in the plant of the Consolidated Paper Co., better known as the Binder Box Factory, at Aurora, Ill., killing one man and badly damaging the plant. The wheel was 14 ft. in diameter and weighed approximately 20 tons. One large piece was hurled through the roof and dropped through the tile roof of the Western Wheel Scraper Co., more than a hundred yards away.

A third accident was reported to have occurred about the same time at the Upper Union Mill of the Carnegie Steel Co., near Pittsburgh. No one was injured, although the property damage is said to have been considerable.

Engineers To Discuss Power In Industrial Plants

The tentative program for the Conference on "Conservation of Power in Industrial Plants," which is to be held at the Engineers' Club of Philadelphia, Feb. 16, is as follows:

"When Is the Private Power Plant Justified," by David Moffat Myers, consulting engineer, New York City.

"Operating a Private Power Plant in Competition with Purchased Power," by Thomas V. Balch, supervising engineer, Equitable Bldg., New York City.

"When Is Purchased Power Justified," speaker not yet selected.

"High-Pressure Prime Movers in Industrial Plants," by J. F. Johnson, Westinghouse Electric & Manufacturing Co.

"Use of Exhaust Steam for Process Work in Textile Plants," by Samuel Greene, consulting engineer, Springfield, Mass.

"Heat Insulation," by L. B. McMillan, chief engineer, Johns-Manville, Inc., New York.

"Power Transmission Economies," by William Staniar, transmission engineer, du Pont Co., Wilmington, Del.

"Lubrication and Bearings," by John D. Gill, Atlantic Refining Co.

"Plant Illumination," speaker not yet selected.

"Economy in the Use of Power." Under this head there will be addresses on "Load Factor," "Power Factor," "Economical Voltages."

Exports of Power Machinery for First Half of 1925

According to figures compiled by the Bureau of Foreign and Domestic Commerce of the Department of Commerce there was exported during the first six months of 1925: 338 stationary steam engines costing $254,363; 35 mechanical drive turbines at $381,884; boilers having 392,756 sq.ft. of heating surface at $1,000,702; waterwheels and water turbines for the same period amounted to 36 at $73,126; electric generators under 500-kw. d.c., were 1,869 at $398,713; electric generators of 500-kw. and over, d.c., 17 at $172,448; electric generators under 2,000-kva a.c., 162 $147,583; Diesel and semi-Diesel engines were 258 at $266,762; ice making equipment of 1,785,191 pounds at $354,120, while exports of ice-making equipment to non-contiguous territory were 314,814 pounds at $71,252; refrigerating equipment over 10 tons capacity of 1,174,407 at $230,436.

Halligan Appointed Chief Engineer of the Navy

The Secretary of the Navy announced on Oct. 26 that President Coolidge had appointed Captain John Halligan, Jr., chief of the Bureau of Engineering of the Navy with the rank of Rear Admiral. The appointment fills the vacancy caused by the expiration of the term of Capt. J. K. Robison.

The appointment is regarded as of unusual significance in that Captain Halligan was one of the chief opponents of the policy of leasing naval oil reserves to private interests. Probably more than any other officer he fought the action of Secretaries Denby and Fall in undertaking the venture, his letters of protest forming an important part of the Senate's investigation material.

The professional experience of Rear Admiral John Halligan, Jr., has been such as to fit him peculiarly for the post of chief engineer of the Navy and as the directing head of its Bureau of Engineering. Until recently he has been in charge of the naval engineering experiment station at Annapolis. Prior to that time Admiral Halligan was head of the engineering post-graduate schools at the Naval Academy. In 1912 he made a special study in England of turbine machinery. In addition he has served in the design division of the Bureau of Engineering and as senior engineer officer on the U. S. S. "Nebraska." This is in addition to his services in command of the "Ohio" and second in command of the "Detroit." He was in charge of the battleship "Iowa" during the recent radio-control experiments with that vessel.

Admiral Halligan was born in South Boston, May 4, 1876. He was graduated from the Naval Academy in 1898, at the head of his class. He saw active service during the Spanish American war and was attached to the U. S. S. "Brooklyn" during the naval battle off Santiago de Cuba. During the World War he served as aide on the staff of the commander of the patrol force of the Atlantic Fleet and later was chief of staff to the commander of the U. S. naval force in France.

New Conowingo Plan Submitted at Baltimore Hearing

Counsel for the Philadelphia Electric Co. sought to meet the Philadelphia Rapid Transit Co.'s criticisms of the financial and structural weaknesses of the Conowingo project, the $52,200,000 hydro-electric development planned on the Susquehanna River, by submitting a modified engineering plan at the conclusion of the hearings before the Public Service Commission of Maryland at Baltimore, Oct. 30.

The revised plan carried no rebuttal of the transit company's contention that the scheme was devised primarily for the benefit of financial promoters and that the uneconomic features of the development were calculated to jump the cost to $100,000,000, with a consequent increase in rates to Philadelphia current-consumers.

The electric company plans to transmit and distribute the current generated to Philadelphia. The P. R. T. is the largest single consumer of P. E. current in that city.

The hearing was conducted by Commissioners Harold D. West, chairman; Ezra B. Whitman and J. Frank Harper, of Maryland. Henry J. Scattergood and Harold D. Evans, of the Pennsylvania commission, and O. C. Merrill, of the Federal Power Commission, also reviewed the proceedings at the invitation of the Maryland utilities body. The P. R. T. was not represented. William Clarke Mason appeared for the electric company. Walter Johnson, president of the Philadelphia Electric Co.; Dr. W. C. L. Eglin, vice-president and chief engineer of the P. E., and Horatio G. Lloyd, of the banking house of Drexel & Co., financial promoters of the enterprise, were in attendance.

At the conclusion of the hearing Clarence W. Miles, people's counsel of Maryland, warned the Commission that it should not sanction the project without first threshing out the question of adequate jurisdiction. While the Susquehanna Power Co. and the Susquehanna Electric Co., holding and operating bodies, respectively, of the Philadelphia Electric Co., in its intercorporate set-up, were within the regulatory control of Maryland, Mr. Miles pointed out the securities for the enterprise would be issued in Pennsylvania, outside the control of Maryland.

Mr. Miles also stressed the possibility of the Conowingo development impairing the efficiency of the Holtwood plant of the Pennsylvania Water Power & Light Co., which is operated just above on the Susquehanna River, and cited the probable effect that would have on the adjustment of service and rates to the Baltimore consumers who are served by that corporation.

L. A. Williams, appearing for the Philadelphia Electric interests in Maryland, opened the hearing by announcing that the "coal clause" in the agreements submitted might well be eliminated. The P. R. T., during hearings before the Public Service Commission of Pennsylvania, had severely critized that clause because of the provision which would have allowed a sliding scale of profits to the P. E. in the event of rises in price of coal for which water energy had been substituted.

"However," said Mr. Williams, "we cannot change the corporate set-up without weakening the proposed issuance of securities."

The Pennsylvania Commission previously had suggested that the P. E. present an alternative plan for intercorporate set-up which would allow of more adequate jurisdiction.

A conference of the Commissions of Pennsylvania, Maryland and the Federal Power Commission was held at Harrisburg on Nov. 9, too late for inclusion in this article of the results or decisions which may have been arrived at.

"Mackinac's" Captain and Asst. Engineer Exonerated

CAPTAIN GEORGE W. McVAY and George C. Mullen, assistant engineer of the excursion steamer "Mackinac," on which a boiler exploded last August, described in *Power*, August 25, page 307, taking a toll of 53 lives, were found not guilty by Federal steamboat inspectors, who heard the evidence in their cases charging negligence in connection with the explosion on Nov. 4. John A. Grant, chief engineer of the "Mackinac," several weeks ago was found guilty of negligence and his Federal license was revoked.

The Federal inspectors ruled that Mullen had reported a leak in the boiler to Grant before the start of the fatal excursion and that Captain McVay had never been informed of the condition of the boiler.

Eighteen Mile Creek Water Rights Hold Up Diversion

Before the Federal Power Commission will be willing to issue permanent rights to the Niagara Falls Power Co. for the use of the remainder of the 500 cu.ft.-sec. of treaty water originally reserved for possible power use down the barge canal, arrangements must be made for each of those who claim water rights on Eighteen Mile Creek, to comply with the terms of the license it is proposed to issue to the Hydraulic Race and Newfane Mill Owners Association. Negotiations are in progress for the purchase of the properties of two interests who do not wish to utilize the water in accordance with the terms of the proposed license. When that arrangement has been completed, a permanent license will be issued the Niagara Falls Power Co. for the 225 sec.ft. remaining.

In the meantime measurements of the diversion from the barge canal, through Eighteen Mile Creek, are being made by the Niagara Falls Power Co. under federal and state supervision. As another step to insure the observance of the boundary water treaty, an exact determination is to be made of the amount of water being spilled down Eighteen Mile Creek.

Export of Coal and Coke Shows Decrease

According to government reports there was exported during the nine months, Jan.-Sept. 1925, 2,750,195 long tons of anthracite, 11,273,374 long tons of bituminous coal and 563,113 long tons of coke.

Opening of "Columbia" Station Postponed

The opening of the new "Columbia" station, formerly called the Miami Fort plant, of the Columbia Gas & Electric Co., Columbia, Ohio, which was announced as for Nov. 12, in *Power*, Oct. 27 issue, page 668, has been postponed until Dec. 10.

Pit River No. 3 Turbines Tested

Acceptance tests just completed on the three 33,000-hp. Pelton vertical-reaction turbines at the new Pit River No. 3 power house of the Pacific Gas & Electric Co., showed a maximum efficiency of 93 per cent. The turbines operate under an effective head of 280 ft. Water measurements were made by the Allen salt-velocity method, and the utmost care in all respects was used in conducting the test. The fourth plant in the series of eight proposed, will be started at once.

Stocks of Gas & Fuel Oils In Storage

According to a table published by the Bureau of Mines, there were, on Sept. 30, 1925, stocks of gas and fuel oils in storage, held by the refining companies the following amounts: East Coast, 310,174,000 gal.; Appalachian district, 36,496,000 gal.; Indiana, Ill., etc., 68,733,000 gal.; Okla., Kan., etc., 196,170,000 gal.; Texas, 370,216,000 gal.; Louisiana and Ark., 207,685,000 gal.; Rocky Mountain, 66,961,000 gal.; Texas Gulf Coast, 301,210,000 gal.; Louisiana Gulf Coast, 185,866,000 gal.

D. Connelly Boiler Co. Has Fiftieth Anniversary

The D. Connelly Boiler Co., of Cleveland, recently celebrated the fiftieth anniversary of the founding of the concern by Daniel Connelly. The once modest business founded in a little shop today occupies a most efficiently equipped manufacturing plant.

A gold loving cup was presented by the employees, some of whom have been with the company for fifty, some forty-seven and some twenty-five years, to the two sons of Daniel Connelly, who succeeded their father in the ownership of the company.

The first product of the company consisted of 25-hp. boilers for the oil industry. The production of return-tubular boilers of from 20 to 150 hp. began ten years later and the Scotch marine boilers ranging up to 250 hp. in size were built shortly after. The principal product of the company today is a patented water-tube boiler of from 200 to 3,000 hp. for steam pressures up to 400 pounds.

Muscle Shoals Commission's Report May Be Delayed

Large Scale Production of Fertilizer Advocated by Some—New Offer for Shoals—Fertilizer Needs of Country Outlined to President

SUBMISSION of the findings of the Muscle Shoals Commission to the President is likely to be delayed beyond Nov. 15, the date originally fixed for the completion of the report. The President has been informed of the difficulties that have arisen in the Commission. He has indicated, however, that he has not given up hope that the differences of opinion among the members may be ironed out to the extent that they may agree on some recommendation for the disposition of the government's properties at Muscle Shoals.

Chairman McKenzie and Commissioners Dial and Bower are understood to favor large-scale manufacture of fertilizer at Muscle Shoals. While they state that they prefer that private enterprise undertake this operation, they are at the same time insisting upon guarantees as to output.

While Commissioners Curtis and McClellan are said to stand for the separation of the fertilizer and power phases of the project, it is believed that they would agree to the allocation of a relatively small amount of power which could be devoted to the experimental manufacture of fertilizer on a large enough scale to be semi-commercial in character. It is believed that an intensive effort will be made prior to the opening of Congress to bring out of the Muscle Shoals Commission a report that the President will be willing to pass on to Congress with his approval. In fact, the President is said to have expressed this wish. It is known to be his hope that this report will present facts, as distinguished from opinion and deduction, which will enable Congress to make a speedy disposition of the matter. It also is known, however, that the President has not changed the position he has taken in his previous communications to Congress on the subject. He is represented as having said that he regards the fertilizer phase of the question as a very important one.

It is reported in the press that Fred C. Hepburn, former vice-president of the Penn Public Service Co., and a group of New York men have submitted a bid for the operation of Muscle Shoals under a fifty-year lease. They guarantee to produce all the fertilizer that the market will consume with or without profit, at an annual rental of $2,000,000.

The bidders agreed upon a $15,000,000 corporation to take over all the Government's holdings at Muscle Shoals. In addition to manufacturing fertilizer they said they would produce other chemicals.

The Farm Bureau has filed two statements concerning the fertilizer needs of the country, with the President. One refers to the needs of the South and the other is devoted to the situation of two typical mid-western states, Michigan and Missouri.

The majority report of the Muscle Shoals Commission stipulates that ninety days after the passage of necessary legislation the government should begin operation of Muscle Shoals if a satisfactory private lease has not been accepted.

San Francisco Disapproves Private Power Distribution

In electing nine supervisors of the "minority group" ticket at the municipal election on Nov. 3, San Francisco voted disapproval of the sale of hydro-electric power from its Hetch Hetchy municipal project to a private corporation for distribution in the city.

This group, in its platform, opposed the contract recently entered into between the city and the Pacific Gas & Electric Co. for the sale of Hetch Hetchy power, and favored acquisition of a municipally owned distribution system. It also stood for lower taxes.

New England Power-Control Arrangement Announced

The new Eastern States Power Corp., organized by the Carlisle and Schoellkopf public-utility interests, is to acquire a large interest in the common stock of a company which will control the New England Power System, it was announced recently. Substantial amounts of the common stock of that company, it was said, would also be acquired by or on behalf of the Power Corporation of New York, which is controlled by the Carlisle interests, by Stone & Webster, Inc., and associates, the International Paper Co. and interests previously identified with the New England Power System.

Washington State Considering New Power Bill

A bill permitting municipalities in the State of Washington owning or operating their own light and power plants to sell excess power outside their corporate limits was introduced at the special session of the Washington legislature which convened Nov. 9. Under the bill a city may sell any surplus energy to any other municipal or governmental agency which owns or operates its distribution system and which is situated within 75 miles of the city limits of the city owning the generating plant, or within 25 miles of its transmission lines. It further provides that sales may be made to any person, firm or corporation within 10 miles of the city generating the power or within three miles of its transmission lines. Proponents of the bill claim that these restrictions would prevent cities from going into the wholesale power business such as permitted under the Bone Bill, which was defeated at the November, 1924, election.

French Engineers Tendered Farewell Dinner

The French engineers who have been visiting the United States, studying the electrical industry and inspecting the larger power plants, were tendered a dinner at the University Club, New York City, Nov. 5, which was attended by about eighty of the leading electric and power men. Anson W. Burchard, chairman of the board of the International General Electric Co., presided. Addresses were made by Albert Petsche, J. W. Partridge, J. E. Aldred, Maurice Saurel, M. S. Sloan and Michael I. Pupin. This party of French engineers arrived in New York City on Sept. 23 (*Power*, Sept. 22, page 469) and left on Nov. 6 for France.

Government Specifications Are Now Standardized

Up to Oct. 1 the Federal Specifications Board, which has been in existence about four years, has promulgated 339 master specifications for the use of the departments and independent establishments of the government, according to the Bureau of Standards of the Commerce Department. In many ways this is one of the most remarkable developments that has taken place in the government service. The preparation of these specifications represents an enormous amount of work, but the results are well worth the effort. Government purchasing has now been placed on a scientific basis and is being conducted along lines which are satisfactory to buyer and seller.

It is significant to note that these specifications are being used extensively outside the government service, a real indication of true value.

Tri-State Commission Organizes

At an organization meeting of the Joint Power Commission of New York, Pennsylvania and New Jersey, held at Princeton, N. J., on Oct. 31, Dr. Charles Browne of Princeton, of the Board of Public Utilities Commissioners of New Jersey, was chosen chairman; William A. Prendergast, chairman of the Public Service Commission of New York State, was chosen vice-chairman, and Phillip P. Wells, assistant attorney general of Pennsylvania and chairman of the Pennsylvania Power Board, was made secretary.

It was decided to ask the Governors of Delaware, Connecticut, Massachusetts, West Virginia, Maryland and Virginia to appoint representatives to sit with the commission as observers and advisors as to the attitude their states would be likely to take.

The commission plans to study power development, transmission and regulation in these three states and to recommend legislation so that the states will be able to decide their course of action under the compact clause of the Constitution which gives the individual states the right to enter into compacts as to transportation among themselves, making it unnecessary that the question should come before the Interstate Commerce Commission.

The question of superpower, it was said, is important for the states, and it was believed advisable that they should decide the questions as to the disposal of the power themselves.

It is believed that should the Interstate Commerce Commission have control, New Jersey, through which the high-voltage cables would naturally run, might not receive the amount of power it needed.

An executive committee was appointed by the chairman, consisting of C. R. Vannerman, chief engineer of the Public Service Committee of New Jersey; Phillip P. Wells, vice-chairman, and Robert F. Engle, of Morristown, N. J., member of the New Jersey Board of Commerce and Navigation.

Trade Commission Dismisses Permutit Co. Complaint

The Federal Trade Commission has dismissed its complaint against the Permutit Co., 440 Fourth Ave., New York City. The firm is a manufacturer of an apparatus used in softening hard water, and in the complaint it was charged with intimidating and coercing customers of its competitors by threats that they would incur liability for using an alleged infringement of respondent's patents.

Detroit Engineers Named for Smoke Abatement Board

The Smoke Abatement Ordinance of Detroit, which was prepared under the direction of the Smoke Abatement Committee of the Board of Commerce and which was passed by the council and signed by the Mayor, provides for an advisory board which is to have final decision in ordering changes in plants violating its provisions. Mayor Smith has appointed engineers as follows: Henry J. Brennan, vice-president W. E. Wood Co.; Frederick K. Boomhower, Albert Kahn Co.; Morgan B. Smith, Detroit Edison Co. Qualification for the Chief Smoke Inspector are about to be drawn up, it is reported.

Obituary

Reginald Francis Halliwell, a member of the staff of the British Thomson-Houston, Co., Ltd., and the company's principal designer of steam turbines died on Oct. 10. Mr. Halliwell was born in 1871, and after receiving a general education at Brighton College, entered the works of the South Coast Railway Co. as a pupil apprentice. Subsequently, he gained experience as a sea-going engineer and held positions with Willans & Robinson, Ltd., Tubes Ltd., and John I. Thornycroft & Co., Ltd. In August, 1903, he joined the British Thomson-Houston Co., Ltd., where he finally reached the position which he held at his death.

Personal Mention

John W. White has been appointed general manager of the recently formed Westinghouse Electric Co. of Japan, and left for the Orient on Oct. 30.

V. F. Brown, formerly operating engineer of the Connors Creek plant of the Detroit Edison Co., has been appointed assistant plant engineer of the Trenton Channel plant.

Philip A. Lang, special European representative of the Westinghouse Electric & Mfg. Co., and for many years works manager of the East Pittsburgh plant, is visiting the United States.

S. B. Way has been elected president of the Milwaukee Electric Railway & Light Co. to succeed the late John I. Beggs. Mr. Way has long been connected in an engineering and executive way with the North American Co.'s subsidiaries in Milwaukee and St. Louis.

George T. Armitage, chief engineer of the Hotel Traymore, Atlantic City, has just returned from a vacation trip through the Panama Canal to San Francisco, coming back overland. Mr. Armitage is active in the councils of the National Association of Stationary Engineers and other engineering organizations.

William Allen Shoudy, consulting engineer, who has been connected with the design and operation of many power plants, notably the steam station of Muscle Shoals and the extension of the Amsterdam station of the Adirondack Power & Light Corp., and whose studies and intensive experience in the combustion field have been of unusual extent, has become associated with David Moffat Myers in consulting work in the industrial power-plant field, with offices at 1 Madison Ave., New York City.

Society Affairs

The New York Chapter No. 2 of the National Association of Practical Refrigerating Engineers will hold its Nov. 12 meeting at the Cafe Boulevard, Broadway and 41st St. at 8 p.m.

The Boston Section of the A.I.E.E. will have an illustrated lecture on "The Trend in Power Stations and Substation Machinery Development," by Frank D. Newbury, of the Westinghouse company for its Nov. 10 attraction. The meeting will be at 715 Tremont Temple.

The Metropolitan Section of the A.S.M.E. will hold a meeting on Nov. 12 at the Engineering Societies Bldg., 29 West 39th St., New York City, at 8.15 p.m. The subject of the evening will be "Subterranean Heat." John W. Lieb, of the New York Edison Co., will preside. The program has been enlarged since the last announcement of this meeting. It is as follows: L. P. Breckenridge, professor emeritus of mechanical engineering, Yale University, will open the session with a paper on "Subterranean Heat as a Source of Power"; George Otis Smith, U. S. Geological Survey will speak on "Heat Rich Areas of the United States"; J. D. Galloway, consulting engineer, of San Francisco, will speak on "Developing Natural Steam Wells at the Geysers, Calif."; George A. Orrok, consulting engineer, of New York City, will speak on "The Thermodynamics of the Flow of Subterranean Heat"; Frank A. Perret, Esq., K. I. C., volcanologist, will speak on "Volcanism as a Source of Power."

The Lehigh Section of the A.I.E.E. will hold its Nov. 13 meeting at the Schuylkill Country Club, Pottsville, Pa. Farley Osgood will speak on "Power, Electrical and Personal."

The Pittsburgh Section of the A.I.E.E. will hear Joseph Slepian, research engineer of the Westinghouse Electric & Manufacturing Co., speak on "Power Flow in Electrical Machinery," at its Nov. 10th meeting at the Chamber of Commerce Auditorium.

The Rochester Engineering Society will hold its first co-operation meeting on Nov. 13, at the Carnegie Bldg., University of Rochester. Albert A. Northrup of the Stone & Webster Corp., will address the meeting on the following subject: "The Construction of the Caribou 60,000-hp. Hydro-Electric Station Located in the Sierra Nevada Mountains in Plumas County, California, for the Great Western Power Co."

Business Notes

The American Engineering Co., of Philadelphia, manufacturer of Taylor Stokers, Lo-Hed electric hoists and other machinery, announces that its interests in Canada have been taken over by the Affiliated Engineering Companies, Ltd., with headquarters in the Southam Bldg., Montreal. This company has been formed by the merger of the Taylor Stoker Co., Ltd., of Montreal, and The Cleaton Co. (Canada), Ltd. M. Alpern, president of The American Engineering Co., is the chairman of the board of the new company and F. S. B. Heward is president.

The McClave-Brooks Co., Scranton, Pa., announces that: The company is opening a new district sales office in Buffalo, N. Y., to serve all of western and central New York, with I. R. Hoffman, formerly district sales manager of the Scranton district, in charge at 333 Jackson Bldg.; that E. C. Whitmore, formerly chief mechanical engineer of the company, will be in charge of the Scranton district, which includes all of northeastern and central Pennsylvania; the Pittsburgh office is being moved to Cleveland, Ohio, at 508 Leader-News Bldg., with Granville B. Lane as district manager; A. J. Baldwin has assumed the duties of sales and operating engineer in the New York office, 1440 Broadway; Frederick Barnes is now sales engineer in the Philadelphia office, 610 Morris Bldg.

Trade Catalogs

Diesel Engines—The Anderson Engine & Foundry Co., Anderson, Ind. Bulletin No. 33 describes with many illustrations its new or heavy duty type "KD" engine, which has embodied some improvements over its type "K" engine. The sizes run from 50 to 360 hp.

Welding—The Chicago Steel & Wire Co., 103rd St. and Torrence Ave., Chicago, Ill. "Properties of Steel Filler Rods for Gas and Electric Welding" contains material developed by the firm's research department and published in this leaflet for the first time.

Coming Conventions

American Association for the Advancement of Science. Burton E. Livingston, Smithsonian Institute, Washington, D. C. Annual meeting at Kansas City, Dec. 28, 1925, to Jan. 2, 1926.

American Institute of Chemical Engineers—Dr. J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y. Annual meeting at Sinton Hotel, Cincinnati, Ohio, Dec. 2-5.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Convention at Engineering Building, New York City, Feb. 8-12, 1926.

American Institute of Mining & Metallurgical Engineers. Dr. H. Foster Bain, 29 West 39th St., New York City. Annual meeting at Engineering Societies Bldg., New York City, Feb. 15-17.

American Marine Exposition. Peter A. Sensenrg, 15 Park Row, New York City. Exposition to be held in the 212th Anti-Aircraft Armory, 62nd St. and Columbus Ave., New York City, Nov. 9-14.

American Petroleum Institute—R. L. Welsh, 250 Park Ave., New York City. Annual meeting at Biltmore Hotel, Los Angeles, Calif., Jan. 19-21.

American Society of Heating & Ventilating Engineers. F. C. Houghten, 29 West 39th St., New York City. Annual meeting at Hotel Statler, Buffalo, N. Y., Jan. 27-29.

American Society of Mechanical Engineers—Calvin W. Rice, 29 West 39th St., New York City. Annual meeting at New York City, Nov. 30-Dec. 4.

American Society of Refrigerating Engineers, William H. Ross, 154 Nassau St., New York City. Annual meeting at New York City, Nov. 30-Dec. 2.

American Society of Safety Engineers. G. S. Wood, 29 West 39th St., New York City. Meeting at New York City, Nov. 18.

Eastern Ice Manufacturers Association. W. H. Ross, 35 Warren St., New York City. Convention at Hotel Chelsea, Atlantic City, Nov. 23-25.

Iowa Engineering Society. J. S. Dodds, Box 202, Ames, Iowa. Convention at Mason City, Iowa, Jan. 27-29.

Master Boiler Makers Association. Harry D. Vought, 26 Cortlandt St., New York City. Annual convention at the Statler Hotel, Buffalo, N. Y., May 25-26.

Midwestern Engineering Exposition, Inc. George E. Pfisterer, 53 West Jackson Boulevard, Chicago, Ill., general manager. Exposition and power show to be held in Chicago, Jan. 26-30, 1926.

National Association of Practical Refrigerating Engineers. Edward H. Fox, 5707 West Lake St., Chicago, Ill. Sixteenth annual convention and educational exhibition at Statler Hotel, Detroit, Mich., Dec. 8-12.

National Electric Light Association. M. H. Aylesworth, 29 West 39th St., New York City. Forty-ninth convention and manufacturers' exhibition, at Atlantic City, Young's Million Dollar Pier, May 17-21.

National Exposition of Power & Mechanical Engineering. Fred W. Payne and C. F. Roth, Managers, Grand Central Palace, New York City. Exposition at Grand Central Palace, Nov. 30-Dec. 5.

National Marine Engineers Beneficial Association. George A. Grubb, 313 Machinists Bldg., Washington, D. C. Convention at Washington, D. C., Jan. 18.

Society of Automotive Engineers. Coker F. Clarkson, 29 West 39th St., New York City. Annual meeting at the General Motors Bldg., Detroit, Mich., Jan. 26-29.

Society of Naval Architects and Marine Engineers. Daniel H. Cox, 29 West 39th St., New York City. Convention at the Engineering Building, 29 West 39th St., New York City, Nov. 12-13.

Clutches, Magnetic — The Cutler-Hammer Manufacturing Co., 530 Grand Ave., Milwaukee, Wis. Publication P-11 describes these clutches for control of power transmission. Illustrations of installations and diagrams are included.

Fuses—The Chicago Fuse Manufacturing Co., Laflin and 15th St., Chicago, Ill. Pamphlet describing the ferrule contact and knife-blade contact "Union" renewable fuses. These range in size from 1 to 60 amperes for the ferrule type and 65 to 600 amperes for the knife-blade type.

Boiler-Room Operation—The Republic Flow Meters Co., 2240 Diversey Parkway, Chicago, Ill. A series of articles on various subjects has recently been published by this firm. They are: "Boiler Room Operation," by G. F. Gebhardt; "Steel and Its Heat Treatment," by H. M. Boylston; "Heavy Clay Products and Their Manufacture," by C. W. Parmelee.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; *mine run* except Pittsburgh gas slack:

Bituminous. Net Tons	Market Quoting	Nov. 2 1925
Pool 1	New York	$2.75@$3.00
Smokeless	Boston	2.19
Clearfield	Boston	1.85@2.25
Somerset	Boston	1.95@2.40
Kanawha	Columbus	1.55@1.85
Hocking	Columbus	1.50@1.85
Pittsburgh	Pittsburgh	2.15@2.25
Pittsburgh gas slack	Pittsburgh	1.25@1.35
Franklin, Ill.	Chicago	2.25@2.50
Central, Ill.	Chicago	2.15@2.25
Ind. 4th Vein	Chicago	2.25@2.50
West Ky.	Louisville	1.20@1.50
S. E. Ky.	Louisville	1.40@1.65
Big Seam	Birmingham	1.50@2.00
Anthracite, Gross Tons		
Buckwheat No. 1	New York	$2.50@$2.75
Buckwheat No. 1	Philadelphia	2.50@3.00
Birdseye	New York	1.60

FUEL OIL

New York—Nov. 5, light oil, tank-car lots; 28@34 deg. Baumé, 4¾c. per gal., 36@40 deg. 5c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Oct. 27, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.80 per bbl.; 26@28 deg., $1.85 per bbl.; 28@30 deg., $1.90 per bbl.; 30@32 deg., $1.95 per bbl.; 32@36 deg., gas oil, 5c. per gal.; 38@40 deg., 6c. per gal.

Pittsburgh—Oct. 29, f.o.b. local refinery; 30@34 deg., fuel oil, 5¼c. per gal.; 36@40 deg., fuel oil, 5½c. per gal.

Dallas—Oct. 24, f.o.b. local refinery; 26@30 deg., $1.55 per bbl.

Philadelphia — Oct. 30, 27@30 deg., $2.31@$2.37 per bbl.; 18@22 deg., $1.70@$1.76; 13@19 deg., $1.60@$1.66 per bbl.

Boston—Nov. 2, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 4.35c. per gal.; light oil, 28@32 deg. Baumé, 5¾c. per gal.

Cincinnati — Nov. 3, tank-car lots, f.o.b. local refinery, 24@26 deg., Baumé, 6¼c. per gal.; 26@30 deg., 6¼c. per gal.; 30@32 deg., 6½c. per gal.

Chicago—Nov. 3, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.17½ per bbl.; 30@32 deg., $1.30.

New Plant Construction

Ariz., Douglas—Calumet & Arizona Mining Co., G. Jay, Purch. Agt., Warren is receiving bids for a 750 kw. steam turbine and generator to replace turbine and generator disabled in accident here.

Calif., Carmichael—Carmichael Irrigation District, plans election to vote $30,000 bonds for three 75 kva. transformers, 8 mi. pipe line, etc.

Calif., Elk Grove—Carroll School District plans to purchase 220 gal. pressure tank, and ¾ hp. pump, with 10-35 g.p.m. capacity.

Calif., Long Beach—F. B. Dunn, awarded contract for the construction of a 12 story store and hotel building including steam heating system and electric elevators on Ocean Ave. to W. G. Reed, Pacific Southwest Bank Bldg. Estimated cost $850,000.

Calif., Los Angeles—Hotel Holding Corp., awarded contract for the construction of a 12 story hotel on Orange Drive to Trewhitt-Shields, Edwards-Wildey Bldg., $3,000,000.

Calif., Roseville—City Trustees are taking bids about Nov. 18 for the construction of sewer system, including pumping plant, pumps, motors, etc. Estimated cost $25,000. J. W. Meredith is city engineer.

Calif., San Francisco—Whitcomb Hotel, plans the construction of a 7 story hotel annex at Market and 8th Sts. Estimated cost $500,000. C. C. Nason, 250 Whitcomb Hotel, is construction manager.

Conn., Bridgeport—Bullard Machine Tool Co., Brewster and Camfield Sts., awarded contract for the construction of a new steam heating and power plant to Files Engineering Co., 168 Thompson St. Estimated cost $40,000.

Conn., Hartford—One Hundred Eighteen Observation Squadron Connecticut National Guard, is receiving bids for the construction of an armory including central heating plant on Brainard Field. Estimated cost $60,000.

Conn., Hartford—Travelers Insurance Co., 700 Main St., has had plans prepared for the construction of a 10 story office building at Prospect and Grove Sts. Estimated cost $1,500,000. Office of Donn Barber, 101 Park Ave., New York, N. Y., is architect.

D. C., Washington—Bureau of Yards and Docks, Navy Dept., L. E. Gregory, Chm., will receive bids until Nov. 25 for boiler plant equipment including combined feed water heater and V. notch meter, reciprocating boiler feed pumps, condensate storage tank, draft control equipment, blow-off pumps, etc., for Naval Hospital. Spec. 5152.

Ill., Chicago—J. N. Bantsolas, 2357 East 67th St., plans the construction of a 14 story apartment at 67th St. and Oglesby Ave. Estimated cost $1,150,000.

Ill., Chicago—J. E. DeWolfe & associates, Westminister Bldg., are having plans prepared for the construction of 22 story, office building, at Monroe and Clark Sts. $1,200,000. F. D. Chase, Inc., 720 North Michigan Ave., is architect.

Ill., Chicago—H. Goldstine and associates, 160 North La Salle St. is having plans prepared for the construction of 21 story, 180 x 200 ft. office building at Adams and Franklin Sts. Estimated cost $5,500,000. A. S. Alschuler, 28 East Jackson Blvd. is architect.

Ia., Albia—R. W. Winsler Produce Co., plans improvements to cold storage plant, etc. Estimated cost $35,000.

Ia., Audubon—The Iowa Light, Heat & Power Co., plans improvements including 2 boilers, steel smoke stack, etc. Estimated cost $25,000.

La., White Castle—Town Council plans an election Dec. 1 to vote $35,000 bonds of which $28,000 will be used for improvements to electric light plant. Engines, dynamos, etc., will be purchased.

Me., Lewiston—Central Maine Power Co., Water St., plans the construction of a power house here. Estimated cost $80,000. E. W. Mason, Waterville, is engineer. J. C. and J. H. Stevens, 187 Middle St., Portland, are architects.

Md., Baltimore—Mutual Life Insurance Co., 15 South St., awarded contract for the construction of a 6 story, office building at Charles and Chase Sts., to J. Henry Miller, Inc., Eutaw and Franklin Sts. Estimated cost $600,000.

Mass., Leominster — Richardson Piano Case Co., awarded contract for the construction of a boiler house and coal pocket to G. A. Fletcher & Co., 215 Blossom St., Fitchburg. $40,000. Private plans.

Mass., Worcester — Memorial Hospital, Belmont St., awarded contract for the construction of a 4 story hospital to J. A. Bishop & Co., 109 Foster St. Estimated cost $500,000.

Mich., Detroit—W. Bayer, c/o A. Kahn, 1000 Marquette Bldg., Archt., is having plans prepared for the construction of a 7 story apartment including steam heating system on Seward Ave.

Mich., Detroit—Hudson Motor Car Co., 12601 Jefferson Ave., awarded contract for the construction of a power house on Gratiot Ave., to H. G. Christman Co., 315 Stevens Bldg. Owners will purchase boilers, pumps, air compressor, coal elevator, etc.

Mich., Detroit—R. T. Lee, General Motors Bldg., plans the construction of a 4 story apartment including steam heating system, boiler, etc., on Chicago Blvd. Estimated cost $500,000. Private plans.

Mich., Detroit—Westinghouse Electric & Mfg. Co., 4584 Maybury Grand Ave., plans the construction of office, shops, and warehouse buildings including steam heating plant on Trumbull Ave. Estimated cost $500,000. Private plans.

Miss., Gulfport—Bonded Warehouse and Storage Co., is having plans prepared for the construction of 5 story warehouse, with refrigeration plant annex, here. Estimated cost $2,000,000. W. C. Lester, Arcade Bldg., Memphis, Tenn., is architect.

Miss., Vicksburg—Lamp-Gary Mfg. Co., P. O. Box 675, is in the market for a 450 to 500 kw. direct connected generator, twenty-five 5 to 75 hp. motors.

Mo., St. Louis—Saum Architects, 713½ Chestnut St., wants prices and data on ice refrigerating plant for 9 story apartment.

Neb., Grand Island—City awarded general contract for improvements to waterworks including power plant, reservoir, etc. to E. Rokhar, 1743 South 24th St., Lincoln, contract for 2 centrifugal pumps to Commonwealth Electric Co., 417 Broadway, St. Paul, Minn. Total cost $300,000.

N. J., Atlantic City—W. M. Stanton, 1524 Chestnut St., Philadelphia, Pa., Archt., awarded contract for the construction of a 13 story hotel on Pennsylvania Ave. between Pacific Ave. and Boardwalk here, to Taylor Meyer Co., Keystone Bldg., Pittsburgh, Pa. Estimated cost $600,000. Owner's name withheld.

N. J., Newark—I. R. Roe, will soon receive bids for the construction of a 20 story hotel at 31-33 Lincoln Park. Estimated cost $2,000,000. Sharpe, Bready & Petiskin Inc., 50 East 42nd St., New York, N. Y., are architects.

N. Y., Brooklyn—Rubel Coal & Ice Corp., 197 Glenmore Ave., plans the construction of an ice manufacturing plant at 2054 Gravesend Ave. Estimated cost $80,000. Work will be done by separate contract under the supervision of E. M. Adelsohn, 350 Stone Ave., Archt. and Engr.

N. Y., New York—J. G. Abramson, 46 West 46th St., is having plans prepared for the construction of a 14 story hotel at 3rd Ave. and 47th St. Estimated cost $2,500,000. L. A. Abramson, 46 West 46th St., is architect and engineer.

N. Y., New York—Four Hundred Thirty East Fifty Seventh Street Corp., c/o McKim, Mead & White, 101 Park Ave., is having plans prepared for the construction of a 15 story apartment at 428-434 East 57th St. Estimated cost $800,000.

N. Y., New York—Hotel Properties, Inc., c/o Warren & Wetmore, 16 East 47th St., Archts., is having plans prepared for the construction of a 9 story hotel at 500 Madison Ave. Estimated cost $1,000,000.

N. Y., New York—Ninto Building Corp., c/o Sugarman & Berger, 345 Madison Ave., Archts., plans the construction of a 15 story apartment at Riverside Drive and 106th St. Estimated cost $1,000,000. Work will be done by separate contracts under supervision of the architect.

N. Y., New York—Princeton Construction Co., c/o G. F. Pelham, 200 West 72nd St., Archt. and Engr. will build 14 story apartment house, at 1160 Park Ave., by day labor. $1,000,000.

N. Y., New York—Two Hundred Thirty Nine Central Park West Corporation, Inc., H. B. Rubin, 501 7th Ave., awarded contract for the construction of a 15 story apartment at 235 Central Park W. to J. Gilbert, 501 7th Ave. Estimated cost $1,500,000.

N. Y., Yonkers—Yonkers Chamber of Commerce, c/o H. L. Quick, 8 South Broadway, New York, Archt., is having plans prepared for the construction of a 10 story hotel on Broadway here. Estimated cost $1,500,000.

Okla., Blackwell—City voted $40,000 bonds and soon takes bids 1250 kw. steam turbine.

Pa., Chester—Ford Motor Co., B. R. Brown, Const. Engr. Dept., Highland Park, Mich., will receive bids until Nov. 12 for the construction of a group of buildings including power house, oil house, pump, oil storage tanks, etc., at Front St. and Delaware River here. Estimated cost $1,000,000. A. Kahn, 1000 Marquette Bldg., Detroit, Mich.

Pa., Philadelphia—Philadelphia Engineering and Machine Co., 1130 Race St., has awarded contract for the construction of a 50 x 198 ft. shop and boiler house to D. Henwood, 717 South 63rd St.

Tenn., Nashville—Fourth & First National Bank, J. E. Caldwell, Pres., 326 Union St., is having preliminary plans prepared for the construction of a bank and office building at 4th and Union Sts. Estimated cost $1,000,000. Ludlow & Peabody, 101 Park Row, New York, N. Y., are architects.

Tex., Bryan—J. B. Miller, City Mgr., will receive bids until Nov. 24 for improvements to waterworks including 400,000 gal. elevated steel water tank, a new 600 hp. power unit direct connected to 2,300 v. a.c., 60 cycle generator. Estimated cost $40,000.

Tex., Dallas—E. E. Parkhurst, 207 S. W. Life Bldg., has had preliminary plans prepared for the construction of a 10 story apartment including steam heating system, central refrigeration plant and 4 elevators on Gaston Ave. Estimated cost $1,250,000. Young & Young, 207 S. W. Life Bldg., are architects.

Tex., Denison—C. E. Haydon, Engr., is receiving bids for pumping equipment including a 300 g.p.m. dry pit bilge pump or equal for city. Estimated cost $6,000.

Tex., Marble Falls—Marble Falls Textile Mills, c/o J. H. Baston, Pres., Waco, awarded contract for accessory work on dam, excavation, masonry, etc., for hydro-electric station here, to L. L. Winans, 2824 Travis Ave., Ft. Worth. Terrell Bartlett Engrs., Calcasieu Bldg., San Antonio, are engineers.

Tex., Sinton—Sinton Electric & Ice Co., O. McCall, mgr. plans the construction of 30 ton ice plant. $100,000. Private plans.

Wash., Yakima—The Chamber of Commerce, A. Miller, Chm., had tentative plans prepared for the construction of a hotel. Estimated cost $700,000 Austin Co., 1611 Euclid Ave., Cleveland, O., is architect and engineer.

Wis., Milwaukee—Wisconsin Ice & Coal Co., 320 East North Ave., awarded contract for the construction of an ice manufacturing building on 31st St., to E. Steigerwald & Sons, 51st and State St. Estimated cost $30,000. Owner also plans a similar building at 37th Ave. and Orchard St.

Que., Joliette—Joliette Steel Ltd., is in the market for one 50 and one 75 kva., 60 cycle, 2200-550 v. transformers.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

Prices of power plant supplies show little change from those in effect a month ago. Slight fluctuations occurred in minor items such as babbitt metal, wiping cloths, and linseed oil. In electrical supplies, the most notable change was an advance in rubber-covered copper wire.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket		71c. per ft.
Common, 2½-in., cotton-rubber lined	80c. per ft. list less	45%

Air—Best grade

¾-in., per ft.	3-ply	$0.37½	4 ply	$0.46

Steam—Discounts from List

First grade	30–10%	Second grade	40%	Third grade	40–10%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from list apply to rubber transmission belting:

Best grade	50%	Second grade	50–10%

LEATHER BELTING—List price, 24c. per lin.ft. per inch of width for single ply at New York warehouses

Grade	Discount from list
Medium	40%
Heavy	30–10%

RAWHIDE LACING—For cut, best grade, 50%, 2nd grade, 60%. For laces in sides, best, 41c. per sq.ft.; 2nd, 37c. Semi-tanned: cut, 50%; sides, 41c. per sq.ft.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ⅛ in.	$0.90
Asbestos for high-pressure steam, ⅛ in.	1.70
Duck and rubber for piston packing	.90
Flax, regular	1.10
Flax, waterproofed	1.70
Compressed asbestos sheet	.80
Wire insertion asbestos sheet	1.30
Rubber sheet	.45
Rubber sheet, wire insertion	.70
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.25
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.30
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia high pressure		50%
For low-pressure heating and return lines	4-ply	70%
	3-ply	72%
	2-ply	74%

PORTLAND CEMENT—New York, $2.50@ $2.60 per bbl. without bags, in carload lots delivered on job. Bag charge of 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, 3 to 15-in. beams and channels and 3 to 6-in. angles, tees, and plates, all $3.34 per 100 lb.

COTTON WASTE—The following prices are in cents per pound:

	New York	Cleveland	Chicago
White	15.00@22.00	19.00	20.00
Colored	10.00@15.50	18.00	17.00

WIPING CLOTHS—Prices per pound in lots of about 600 lb., for washed, white wipers, as follows:

Chicago	$0.15½
New York	.17½
Cleveland (*per thousand*)	36.00

LINSEED OIL—These prices are per gallon:

	New York	Cleveland	Chicago
Raw in barrels (5 bbl. lots)	$1.00½	$1.15	$1.01

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry		In Oil	
	Current	1 Yr. Ago	Current	1 Yr. Ago
Red	$15.75	$14.75	$17.25	$16.25
White	15.75	14.75	15.75	14.75

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

Rivets, 7/16x1-in. and longer, 19c. per lb., less 50% at New York warehouses. Same discount for tinned. EXTRA per 100 lb. for 1¼ to 2-in. long, all diameters, 25c.; ⅞-in. dia., 35c.; ¾-in., dia., 75c.; 1-in. long and shorter, 75c.; longer than 5-in., 50c.; less than 200 lb., 50c.; countersunk heads, 45c.

Structural rivets, ½, ⅝, 1 in. diameter by 2½ in. to 4½ in. sell as follows per 100 lb.:

New York	$5.00*	Chicago	$3.50	Pittsburgh	$2.40@2.50

Boiler rivets, same sizes:

New York	$5.20*	Chicago	$3.70	Pittsburgh	$2.70@2.90

* For immediate delivery from warehouse.

REFRACTORIES—Prices in carlots f.o.b. plant:

Chrome brick, eastern shipping points	net ton	$48@53
Chrome cement, 40@ 50% Cr_2O_3, in bulk	net ton	23@28
Chrome cement, 40@ 50% Cr_2O_3, in sacks	net ton	27@32
Magnesite brick: 9-in. straights	net ton	65@68
Magnesite brick: 9-in. arches, wedges and keys	net ton	71.50@74.80
Magnesite brick: Soaps and spits	per ton	91.00@95.20
Silica brick: Mt. Union, Pa.	per M	38@40
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per M	40@47
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@45
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	33@40
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	40@43
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	40@43
Chrome ore crude, 40@ 50%	net ton	19.00@20.50

BABBITT METAL—Warehouse prices in cents per pound:

	New York	Cleveland	Chicago
(83% tin)	60.00	72.50	58.00@63.00
(35% tin)	28.00	22.50	30.00@35.00

COLD DRAWN STEEL—Warehouse prices are as follows:

	New York	Cleveland	Chicago
Round shafting and screw stock, per 100 lb. base	$4.15	$3.80	$3.60
Flats, squares and hexagons, per 100 lb. base	4.65	4.30	4.10

BOILER SPECIALTIES—F. o. b. New York or Jersey City, discounts on list:

	Current
Copper ferrules	70%
Boiler flanges	60–10%
Boiler stay bolts	60%
Boiler patch bolts	10%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%
Pressed steel boiler hangers	10%

WROUGHT PIPE—The following discounts are to jobbers for carload lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv
1 to 3	62	50½	1 to 1½	30	13

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 and 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

BOILER TUBES—Following are prices in New York warehouse of tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1	.....	.....	$17 07
1¼	.....	.....	19 20
1½	.....	$38 00	17 92
1¾	.....	28 50	20 48
2	$17 33	25 00	20 24
2¼	19 84	28 25	23 00
2½	21 60	34 00	26 03
3	25.50	42 50	27 04
3½	.....	49 50	30 67
3¾	31.50	52 75	33 33
4	38.03	67 00	40.11

Tubes 2½ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.

These prices are net per 100 ft. based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.

In addition to the above, standard cutting charges are as follows:

2 in. and smaller, 5c. per cut. 3 in., 9c. per cut
2¼ and 2½ in., 6c. per cut. 3½ to 4 in., 10c. per cut

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$36.00 (net)	$ 56.00 (net)	$164.00	$210.00
No. 12 solid	135.00	170.00	225.00	265.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	285.00	375.00	520.00	500.00
No. 6 stranded	400.00	500.00	560.00	.....

From the above lists discounts are:		Lead Covered
Less than coil lots	50%	20%
Coils to 1,000 ft.	55%	25%
1,000 to 5,000 ft.	60%	30%
5,000 ft. and over	60-5%	35%

CONDUIT, Price per 1,000 ft.; **ELBOWS AND COUPLINGS**, Per 100 pieces, f.o.b. New York, with 10-day discount of 5 per cent.

Size In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplings Black Per C	Couplings Galvanized Per C
¼	$56 50	$61 34	$7.76	$8.83	$4.52	$4.92
⅜	72 07	78 63	10 21	11 63	6.46	7.03
1	103 31	113 00	15 10	17 21	8.39	9 13
1¼	139.77	152 88	20 51	23 07	11.78	12 75
1½	167.12	182.79	27.34	30.76	14.56	15.75
2	224 85	245 94	50 13	56 40	19.41	21 01
2½	355.50	388.85	82 03	92 28	27.73	30 01
3	464 88	508 50	218 74	246 10	41.59	45.01
3½	585 30	637 74	483 04	543.46	55.46	60 02
4	714 17	776.30	558.23	628.06	69.32	75.02

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG, SOLID NEUTRAL OR 2 FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID NEUTRAL OR 2 FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy	$23.00
No. 16 cotton reinforced heavy	26.50
No. 18 cotton reinforced light	18.10
No. 16 cotton reinforced light	22 00
No. 18 cotton Canvasite cord	16 75
No. 16 cotton Canvasite cord	19.10
No. 16 super service cord or similar (2 wire)	101.20
No. 14 super service cord or similar (2 wire)	146.40

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30 amp.	100	$0 15	3-amp. to 30-amp.	100	$0.30
35-amp. to 60 amp.	100	30	35-amp. to 60-amp.	100	.60
61-amp. to 100 amp.	50	.90	65-amp. to 100-amp.	50	1.50
101-amp. to 200-amp.	25	2.00	110-amp. to 200-amp.	25	2.50
201-amp. to 400-amp.	25	3.60	225-amp. to 400-amp.	25	5.50
401-amp. to 600-amp.	10	5.50	450-amp. to 600-amp.	10	8.00

Discount: Less 1-5th standard package, 60%; 1-5th to standard package, 65%; standard package, 70%.

RENEWABLE FUSES, ENCLOSED—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4 00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1
450 to 600-amp.	11.00	16 00	10	1

REFILLS—

1 to 30	$0.30 ea.	$0.05	100	100
35 to 60	.05 ea.	.06	100	100
65 to 100	.10 ea.	.10	50	50
110 to 200	.15 ea.	.15	25	50
225 to 400	.30 ea.	.30	25	25
450 to 600	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken carton	5%
Unbroken carton but less than std. pkg.	22%
Std. pkg.	40%
Discount Without Contract—Renewals:	
Less than std. pkg.	Net list
Standard package	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons but less than standard package	26%
Standard package	42%
Discount With Contract—Renewals:	
Less standard package	Net list
Standard package	42%

FUSE PLUGS, MICA CAP OR CLEARSITT—

0-30 ampere, standard package (500)	$2.85
0-30 ampere, less than standard package	3.15

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs Mazda B— Watts	Plain	Frosted	No. in Package	Pear-Shaped Bulbs or Bowl Enameled Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.27	$0.32	120	50	$0.40	$0.45	60
15	.27	.32	120	75	.45	.55	60
25	.27	.32	120	100	.50	.55	24
40	.27	.32	120	150	.65	.70	24
50	.27	.32	120	200	.80	.85	24
60	.32	.37	120	300	1.25	1.35	24
				500	2.00	2.15	12
				750	3.50	3.70	8
				1,000	3.75	3.95	8

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75.00 to $300,000 net allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain separable attachment plug	$0.18
Composition 2-piece attachment plug	.27
Swivel attachment plug	.12
Small size—2 Pc. Plug—Composition	08½

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$7.20	$9.95	$11 80	$18.50
12	10.25	12.98	14.97	24.55
10	13.50	16 90	18 90	31 76
8	18.90	22.90	24 40	42.75
6	.....	.....	35 00	.....
4	.....	.....	47 85	.....
2	.....	.....	68 75	.....
1	.....	.....	89 65	.....
0	.....	.....	120 16	.....
00	.....	.....	142 20	.....
000	.....	.....	169 90	.....
0000	.....	.....	202 67	.....

SOCKETS, BRASS SHELL—

½ In. or Pendant Cap Key Each	Keyless Each	Pull Each	¾ In. Cap Key Each	Keyless Each	Pull Each
$0.36	$0.33	$0.50*	$0.42	$0.39	$0.56*

Less 1-5th standard package	30%
1-5th to standard package	40%
Standard package	45%

* Net.

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 35c. lb., 100 lb. lots	33c. lb.
Rubber tape, ¾ in., less 100 lb. 37c. lb., 100 lb. lots	35c. lb.
Wire solder, less 100 lb. 27c. lb., 100 lb. lots	29c. lb.
Soldering paste, 2 oz. cans	$1.00 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c. or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole, Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	36.00

Discounts:	
Less than $25.00 list value	30%
$25 to $50 list value	30-5%
$50 list value or over	35%